SCIENCE

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CONTENTS

The Organization of Industrial Scientific Research: C. E. KENNETH MEES 763

Benjamin Franklin and Erasmus Darwin, with some unpublished Correspondence: DR. L. HUSSAKOF 773

Sven Magnus Gronberger: F. E. FOWLE 775

Scientific Notes and News 776

University and Educational News 779

Discussion and Correspondence:—
A New Form of Plant Drier: P. L. RICKER. *A New Color Variety of the Norway Rat:* DR. PHINEAS W. WHITING. *Sylvester and Cayley:* PROFESSOR GEORGE BRUCE HALSTED 780

Scientific Books:—
Kaye on Indian Mathematics: PROFESSOR DAVID EUGENE SMITH. *Wraight's Assaying in Theory and Practise:* PROFESSOR OWEN L. SHINN 781

Mosquitoes and Man: DR. C. S. LUDLOW 784

Special Articles:—
The Origin by Mutation of the Endemic Plants of Ceylon: PROFESSOR HUGO DE VRIES. *The Electrical Discharge between Concentric Cylindrical Electrodes:* PROFESSOR CHAS. T. KNIPP 785

The Utah Academy of Sciences: DR. A. O. GARRETT 789

Anthropology at the Washington Meeting ... 790

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THE ORGANIZATION OF INDUSTRIAL SCIENTIFIC RESEARCH

IF one attempted to formulate the common belief concerning the origin and development of modern technical industries, it would probably be found that stress would be laid upon financial ability or manufacturing skill on the part of the founders, but if, instead, we were to make a historical survey of the subject I think that we should find that the starting and development of most manufacturing businesses depended upon discoveries and inventions being made by some individual or group of individuals who developed their original discoveries into an industrial process. Indeed, if the localities in which various industries have developed be marked on the map, they will often be found to have far more relation to the accidental location, by birth or otherwise, of individuals, than to any natural advantages possessed by the situation for the particular industry concerned. The metallurgical industries, of course, are situated chiefly near the sources of the ores or of coal, but why should the chief seat of the spinning industry be in Lancashire or of modern optical industry in Jena except that in those places lived the men who developed the processes which are used in the industry? And, moreover, industries are frequently transferred from one locality to another and even from one country to another by the development of new processes, generally by new individuals or groups of workers.

The history of many industries is that they were originated and developed in the first place by some man of genius who was fully acquainted with the practise of the

industry and with such theory as was then known; that his successors failed to keep up with the progress of the industry and with the theory of the cognate sciences; and that sooner or later some other genius working on the subject advanced the available knowledge and again gave a new spurt to the development of that industry in another locality.

Thus, in the early days of the technical industries the development of new processes and methods was often dependent upon some one man, who frequently became the owner of the firm which exploited his discoveries. But with the increasing complexity of industry and the parallel increase in the amount of technical and scientific information necessitating increasing specialization, the work of investigation and development which used to be performed by an individual has been delegated to special departments of the organization, one example of which is the modern industrial research laboratory.

The triumphs which have already been won by these research laboratories are common knowledge. The incandescent lamp industry, for instance, originated in the United States with the carbon lamp, but was nearly lost to the United States when the tungsten filament was developed, only to be rescued from that danger by the research laboratory of the General Electric Company, who fought for the prize in sight and developed first the drawn wire filament and then the nitrogen lamp; and we may be sure that if the theoretical and practical work of the research laboratory of the General Electric Company were not kept up the American manufacturers could by no means rest secure in their industry, as, undoubtedly, later development in electric lighting will come and the industry might be transferred, in part if not completely, to the originators of any improvement. Manufacturing concerns and especially the powerful, well-organized companies who are the leaders of industry in this country, can, of course, retain their leadership for a number of years against more progressive but smaller and less completely organized competitors, but eventually they can ensure their position only by having in their employ men who are competent to keep in touch with and themselves to advance the subject, and the maintenance of a laboratory staffed by such men is a final insurance against eventual loss of the control of its industry by any concern.

There was a time when the chief makers of photographic lenses were the British firms whose owners had been largely instrumental in developing the early theory of lens optics, but that position was lost entirely as a result of the scientific work of the German opticians, led by Ernst Abbe; in a smaller division of optical work, however, the staff of Adam Hilger, Ltd., has been able by its superior knowledge and intensive study of the manufacture of modern spectroscopes to transfer a large portion of the manufacture of such instruments from Germany to England again.

In a recent book review in *Nature* of December 2, page 366, it was pointed out that the rare earth industry has been chiefly concentrated in Germany. The manufacture of gas mantles, discovered by an Austrian, developed an entirely new chemical industry which has been carried on almost completely under German auspices. It seems to be suggested at the present time by some of the leaders of British industry that such specialized chemical operations as the manufacture of compounds of the rare earths can be transferred to Great Britain by the application of superior financial methods or better business foresight or even merely more intense application. I do not believe that any one who is acquainted with

the business men of several countries will believe that the British manufacturer is lacking either in financial capacity or in business foresight or in application, but none of these things by themselves will develop a chemical industry. The only thing that will attract and retain the business is the manufacture and development of new and improved products, and this can be done only by the use of more and better research chemists and physicists than the competitor is willing to employ. In fact, at the present time it seems to be clear that the future of any industry depends upon its being able to command a sufficient supply of knowledge directed towards the improvement of the product and the development of the methods of that industry, and that any failure in this respect may involve eventual failure. While this view of the importance of research work to the industries is now obtaining universal acceptance, I feel that many who assent without hesitation to the value of a research laboratory still take far too low a view of the work which it should perform.

Industrial laboratories may be classified in three general divisions:

1. Works laboratories exerting analytical control over materials or processes.
2. Industrial laboratories working on improvements in product and in processes, tending to lessen cost of production and to introduce new products on the market.
3. Laboratories working on pure theory and on the fundamental sciences associated with the industry.

The first class of laboratory is so obviously necessary that practically all works are so equipped, and frequently each department of a factory maintains its own control laboratory. The second class of laboratories are frequently termed "research" laboratories, and this type has been very largely instrumental in forwarding the introduction of scientific control into industry.

Unfortunately, however, the immediate success of the application of scientific methods to industrial processes has often led the executives of commercial enterprises into the belief that such work along directly practical lines is capable of indefinite extension and in this belief a number of laboratories have been started, some of which, at any rate, have been sources of disappointment in consequence of a failure to grasp the fact that if the whole future of an industry is dependent on the work of the research laboratory, then what is required is not merely an improvement in processes or a cheapening in the cost of manfacture but fundamental developments in the whole subject in which the manufacturing firm is interested; for this purpose it is clear that something very different from the usual works laboratory will be required, and that in order to obtain progress the work of the research laboratory must be directed primarily toward the fundamental theory of the subject. This is a point which seems to be continually overlooked in discussions of industrial scientific research, where much stress is generally laid upon the immediate returns which can be obtained from works laboratories, and upon the advantage of scientific control of the operations; but in every case where the effect of research work has been very marked, that work has been directed not towards the superficial processes of industry but toward the fundamental and underlying theory of the subject. From Abbe's work on lenses, and Abbe and Schott's work on glasses, to the work of the research laboratory of the General Electric Company on the residual gases in lamp vacua, which resulted in the production of the nitrogen tungsten lamp and the Coolidge X-ray tube, this will be seen to be

true, and we must consequently agree that for industries to retain their position and make progress they must earnestly devote time and money to the investigation of the fundamental theory underlying the subject in which they are interested.

Research work of this fundamental kind involves a laboratory very different from the usual works laboratory, and also investigators of a different type from those employed in a purely industrial laboratory. It means a large, elaborately equipped, and heavily staffed laboratory engaged largely on work which for many years will be unremunerative and which, for a considerable time after its foundation, will obtain no results at all which can be applied by the manufacturer.

The value of a research laboratory is essentially cumulative; in the beginning it may be of service as bringing a new point of view to bear on many problems; later, accumulated information will be more and more available; but most men acquainted with industrial research work consider that five years is the earliest date at which any considerable results can be expected from a newly established research laboratory and that the development of really new material in considerable quantities so that it will have an effect upon the industry as a whole can not be looked for in less than ten years' consecutive work. This does not mean that a laboratory is useless during the initial period, since it will be of considerable service in many other directions than in that of its main work on the fundamental problems, but when this main line of research begins to bear fruit it will absorb the energies both of the laboratory and of the factory.

It is often suggested that the problem of the organization of scientific industrial research is really the problem of obtaining satisfactory cooperation between the manufacturers and the universities, possibly with small research laboratories in the factories themselves acting as intermediaries. Various schemes have been suggested for enabling the universities to carry out research work of value to the manufacturers, but if it is believed that the work chiefly required for the development and maintenance of industry deals with the fundamental theory of the subject, it will be seen that this can not possibly be carried on to any large extent in collaboration with a university; it requires a continuity of application by the same investigators over long periods with special apparatus and with the development of special methods which can not be expected from any university. This necessity for continuous work along the same line is, indeed, the greatest difficulty in making use of the universities for industrial research. The conditions of a university laboratory necessarily make it almost impossible to obtain the continuous application to one problem required for success in industrial research and, indeed, in the interests of teaching, which is the primary business of a university, such devotion to one problem is undesirable, as tending to one-sidedness.

There are also difficulties in obtaining the cooperation of manufacturers with universities and in the application of university work to industry, which I see no hope whatever of overcoming; the universities do not understand the requirements of the manufacturer and the manufacturer distrusts, because he does not understand, the language of the professor. Moreover, it is quite essential that any investigator who has worked out a new process or material should be able to apply his work on a semi-manufacturing scale so that it can be transferred to the factory by skilled men who have already met the general difficulties which would be encountered in factory application. This development on a semi-

manufacturing scale is, indeed, one of the most difficult parts of a research resulting in a new product, and the importance of it is shown by the fact that all the large industrial research laboratories, however concerned they may be with the theory of the subject, have, as parts of the laboratory and under the direction of the research staff, experimental manufacturing plants which duplicate many of the processes employed in the factory itself.

All these arguments tend to show that an industrial research laboratory must necessarily be of considerable size, but this requirement is much accentuated by another consideration altogether.

Except in a few branches of pure science small research laboratories are relatively inefficient, in the technical sense of the term, that is, they require more time and cost more money for the solution of a given problem.

When considering this subject it is necessary first to dismiss from the mind completely the idea that any appreciable number of research laboratories can be staffed by geniuses. If a genius can be obtained for a given industrial research, that is, of course, an overwhelming advantage which may outweigh any disadvantages, but we have no right to assume that we can obtain geniuses; all we have a right to assume is that we can obtain at a fair rate of recompense, well trained, average men having a taste for research and a certain ability for investigation. The problem, then, is how can we obtain the greatest yield from a given number of men in a given time? Investigation of the subject shows that the yield per man increases very greatly as the number of men who can cooperate together is increased. The problems of industrial research are not often of the type which can be best tackled by one or two individual thinkers, and they rarely involve directly abstract points of theory, but they continually involve difficult technical and mechanical operations, and most of the delays in research work arise because the workers engaged on the subject do not know how to do some specific operation. In my own experience, I have seen a good man stick for six months in an investigation because he did not know and could not find out how to measure a conductivity with a precision higher than one part in a thousand, a point which was finally found to be perfectly well known to several scientific workers in the country. Again, it took another good man three months to learn how to cut a special form of section, but having learned the trick he can now cut sections for all the workers in the laboratory with no delay whatever.

In this connection the advantage of permanent set-ups of apparatus may be pointed out. Among a large number of chemists some one will continually be wanting to photograph an ultra-violet absorption spectrum or to take a photomicrograph, and if the apparatus for these purposes is erected and in charge of a competent man who understands its use, the work can be done without any delay at all, the photography of the absorption spectrum of an organic liquid by a man who is used to the work taking only an hour; but if this point is vital to the research and the chemist is quite unacquainted with the technique of the subject and has no apparatus available, it may easily take him six months to find out what has been done on absorption spectra, to buy and erect the apparatus, and become skilled in its working.

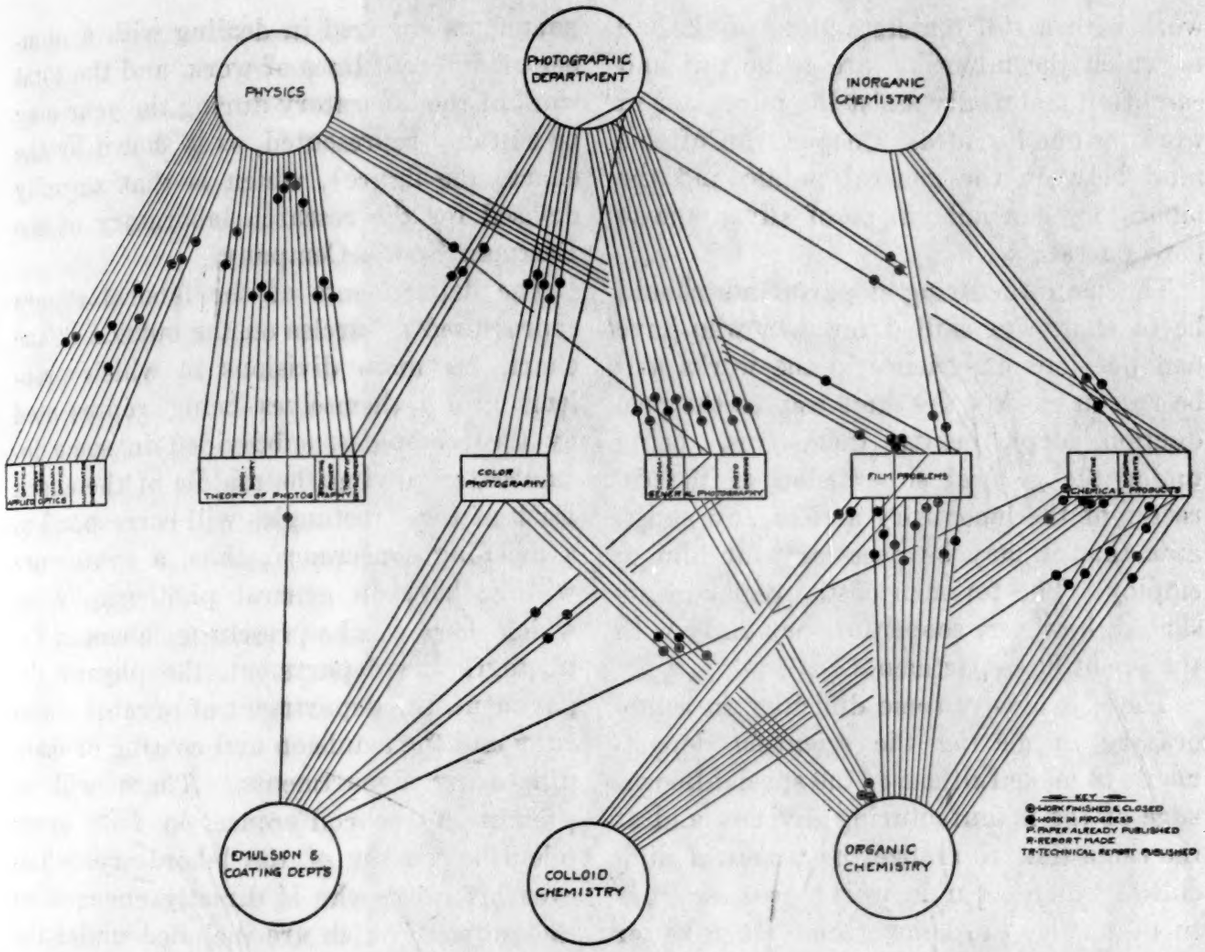
From these causes, then, the efficiency of a laboratory increases very greatly with its size provided that there are good arrangements for cooperation between the different workers of the laboratory so that they are kept informed of each other's problems.

When considering the efficiency of research work it must be remembered that the efficiency is necessarily extremely low since it is very rarely possible to arrange any research so that it will directly proceed to the end required.

It is the common opinion of those who have to deal with the organization of research that only a small percentage of all the investigations started are likely to be successful, the great majority being either dropped before they come to an end, or being carried through, and filled simply as records, without any results having been obtained which would justify the expense of the investigation; that is to say, industrial research is justified only by the great value of the successful attempts, and these must bear the burden of a great number of unsuccessful attempts which may have been quite as costly as the successful ones themselves. The object of organization is to attempt to reduce the proportion of unsuccessful investigations which will be undertaken, as has already been shown. This can be done by increasing the size of the laboratory, by increasing the specialization of the workers, and especially by increasing cooperation between workers in different fields.

Naturally, the most important step which could be taken to increase the efficiency of industrial research would be to increase the likelihood of correct choice of a promising investigation, but, unfortunately, very little can be done in this direction. Those with the most experience in research work are all agreed that it is almost impossible to say whether a given investigation will prove remunerative or not. The only general conclusion that can be drawn is that the deeper a given investigation goes towards the fundamentals of the problem the more likelihood there is that the results will be of value, and the more superficial an investigation is, even although it appears more promising at first sight, the less likelihood there is that it will finally prove of real worth, so that the choice of investigations must necessarily be made largely at random and will be influenced to a great extent by the ideas of the scientific workers themselves; if any worker has a desire to take up any particular line of work, provided that it is associated with the general trend of work in the laboratory, it is usually wise to let him do so, but the expedition with which a decision can be reached as to the probable value of the investigation after it has been started is very greatly enhanced by complete cooperation of workers in the different branches of science in consultation on the problem.

At this point it might be well to discuss the organization of a large research laboratory. Such a laboratory should be established in charge of a director who has had some actual manufacturing experience in the work processes but at the same time he must have a considerable sympathy with purely scientific work and an interest in the advancement of scientific theory. *Both* these qualifications are desirable, but if such a director combining the two can not be found, then a man of full scientific training should be chosen and put into a position of responsibility in the manufacturing side of the industry until he has become fully acquainted with the technique of the industry. It is most inadvisable to take a man from the industry who has not had a full scientific training, including advanced research work in academic problems, since he will generally be lacking in sufficient knowledge of and sympathy with the more academic investigations of which he will be in charge and if the two necessary qualifications can not be found united in one man, it will be necessary to take a man with the scientific qualifications and give him the



practical training, which is just as essential for the director of a laboratory as scientific knowledge.

These necessary qualifications in the director are reflected in the division of the laboratory itself into manufacturing and scientific sections, since the manufacturing section should be able to carry out on a small scale all the chief manufacturing operations so that any investigations made in the laboratory can be carried through to the practical works scale without interfering with the production departments. In the research laboratory of the Eastman Kodak Company the manufacturing department includes emulsion-making and plate, film and paper coating departments, the capacity being very considerable, the plate department being able to make 300 dozen 8×10 in. plates a day. These departments are used not only for systematic experiments on emulsion suitable for various purposes, such as different kinds of plate emulsion, color sensitive emulsions, especially for color photography, and experimental printing papers, but they are further used to make on a small scale products which are required for special purposes in very small quantities, such as special plates required by astronomers or spectroscopists or special film required for experimental purposes by those working on color photography or attempting to develop other photographic processes. Requests for such special materials are received by every large manufacturing company, and the execution of the orders in the production departments frequently involves much delay and loss, whereas the manufacturing section of the laboratory can carry out the

work with a full understanding of the use to which the materials are to be put and can often materially assist the purchaser in working out his idea. Cooperation of this kind between the general public and the laboratory can not but be of advantage to both parties.

The manufacturing departments should be in charge of skilled foremen who have had previous experience in the works and be run in exactly the same way as the production departments themselves, being under the general supervision of the director of the laboratory and of any assistants that it may be necessary for him to employ. The foremen of the departments should, however, cooperate very fully with the scientific departments.

There is always some difficulty in a laboratory in getting the scientific departments to make full use of the special knowledge of the manufacturing division and at the same time to realize the practical difficulties which occur in works processes, but this difficulty can be overcome much better in the case of the manufacturing division of the laboratory than it could if an outside production department were involved without the laboratory division acting as intermediary.

The scientific division of the laboratory should be divided into departments dealing with the special subjects, but every care should be taken that these departments do not become at all isolated from each other and that they cooperate with each other in the most complete way on the solution of the problems on which the laboratory is engaged. In order to insure this the main lines of work under investigation may be suitably discussed at a morning conference at the beginning of the day's work, one day of the week being assigned to each subject. The laboratory organization will then resolve itself into a number of different departments engaged in dealing with a number of different lines of work, and the total work of the laboratory during the year may be suitably represented, as is shown by the chart (see figure), which is that actually devised for the research laboratory of the Eastman Kodak Company.

The departments of the laboratory are represented as circles on the outside of the chart, the main divisions in which problems group themselves being represented by the rectangles, subdivided in some instances, occupying the middle of the chart. Each of these rectangles will correspond to a morning conference; thus, a conference will be held on general photography, at which there will be present members of the photographic department, the physics department, the department of organic chemistry and the emulsion and coating or manufacturing departments. There will be present at the conference, in fact, every scientific worker of the laboratory, whatever his rank, who is directly engaged on the subjects which are included under the head of general photography, and in some cases, or on special occasions, members of the staff of the company external to the laboratory may be invited to these conferences, although as a general rule in the case of a large company it will not be possible for them to be regularly present. All the main lines of investigation should be laid down at these conferences and the progress from week to week carefully discussed. This procedure will enable a great saving in time to be made, since it will avoid the loss of time which continually occurs in laboratories from the wrong man doing a specific piece of work; and the economy can be much increased by suitable arrangement of the building and equipment itself.

The building should be so arranged that all the laboratories are open to everybody in the scientific departments but that in

each laboratory involving special classes of apparatus there are specialists continually working who are available for consultation and assistance to all other workers in the laboratory. In this way single operations which become necessary in the course of an investigation may frequently be transferred from the man who has carried on the main line of work on the subject to some other specialist in the laboratory. In the Kodak laboratory, for instance, electrical measurements, photometric measurements, spectrophotography, lens optics, photographic sensitometry, work involving dyestuffs, and all strictly photographic operations, such as copying, lantern-slide making, printing and enlarging, making up developers, etc., are in the hands of specialists, and whenever any of these operations become necessary in the course of an investigation, the conference directs that they be carried out by the specialist on the subject. In this way an organic chemist, for instance, will have the absorption curve of his products measured not by an instrument in the organic laboratory but by the physics department, while the preparation of photographs, lantern slides and prints which are often involved in publication are carried on by the photographic department and not by the man who did the work, these arrangements relieving specialists in one subject from having to acquire technical skill in another. It is in such complete cooperation that the greatest economy in scientific investigation is to be found.

It must be remembered that such specialization as this is not at all suitable for use in a university, where the object is the broadening and education of the students; it is one of the many differences between research work in a university and in a set research laboratory, whether it be industrial or not, that in a university the primary object is the training of the worker, while in the research laboratory the primary object is the carrying out of the investigation.

The best utilization of the results obtained in an industrial research laboratory is only second in importance to the organization required to obtain them. All results of general scientific interest and importance should undoubtedly be published both in the public interest, and also because only by such publication can the interest of the laboratory staff in pure science be maintained. It is doubtful if the importance of maintaining the full interest in theoretical science of a laboratory staff has been fully realized. When the men come to the laboratory they are usually interested chiefly in the progress of pure science, but they rapidly become absorbed in the special problems presented to them and, without definite effort on the part of those responsible for the direction of the laboratory, there is great danger that they will not keep up to date in what is being done by other workers in their own and allied fields. Their interest can be stimulated by journal meetings and scientific conferences, but the greatest stimulation is afforded by the requirement that they themselves publish in the usual scientific journals the scientific results which they may obtain. Another reason for publication is that when a piece of work is written up for publication the necessity for finishing loose ends becomes manifest and that work which is published is therefore more likely to be properly completed.

With some laboratories publication is rendered difficult by the industrial organization; while nominally manufacturing companies are usually willing that results of scientific interest should be published, the organization of the company frequently requires that they be passed on by the heads of several departments, such as the

sales, patent, advertising, manufacturing, and so on, and the heads of these departments, possibly not understanding the subject and being afraid of passing material which might prove detrimental, frequently err very much in the direction of withholding entirely harmless information from lack of sufficient knowledge. It is much more satisfactory, if possible, for one responsible executive to pass on all matter submitted for publication, and this will inevitably result in a much more liberal policy than where the responsibility is delegated to a number of representatives of different departments of the company.

In addition to these scientific papers special technical reports for the information of the staff of the company itself should be circulated by the laboratory, and in the case of the Kodak laboratory an abstract bulletin is published monthly giving information as to the more important papers appearing in the technical journals associated with the photographic industry and also of all photographic patents. It is often advisable, also, to prepare special bulletins dealing with the application of scientific investigations, which have already been published, to the special needs and interests of the company.

Since the evidence points, therefore, to the establishment of really large research laboratories as the most economical and efficient way of increasing the application of science in industrial work the question arises as to how these large laboratories are to be supported. In the United States the great manufacturing corporations, who can afford the necessary capital and expenditure for maintenance, and are willing to wait for the results, have already undertaken the establishment of a number of large research laboratories. Such concerns as United States Steel, General Electric Company, United States Rubber, du Pont de Nemours, and many others are supporting large and adequately equipped research laboratories whose staffs are engaged in work on the fundamental theory of the industries in which they are interested, and undoubtedly more and more such laboratories will be established in the course of the struggle for increased industry which the United States is preparing to wage. There are a large number, however, of smaller firms who can not afford the great expenditures involved but who are anxious to benefit by the application of science to their work, and it seems that the only solution to the problem of providing for such firms is in the direction either of cooperative laboratories serving the whole industry, as has already been done in the case of the National Canners' Association and the National Paint Association, and no doubt in some others, or in the erection of national laboratories devoted to special subjects connected with industry and corresponding to such institutions dealing with special branches of pure science as the geophysical laboratory of the Carnegie Institution. Schemes for industrial scholarships tenable at universities do not meet the case at all, since work done under such arrangements must necessarily be limited in respect to time and directed towards a definite practical end rather than towards the general acquisition of knowledge connected with the underlying principles on which an industry rests. In the same way consulting laboratories, like industrial scholarships, are interested in the development of results for immediate practical application, and both these methods of work are substitutes for the practical industrial laboratories belonging to my second general division rather than for the large laboratories here discussed.

In England the coordination of industry has not proceeded as in the United States

and there are very few corporations who would be willing to maintain a large, fully equipped research laboratory of the type discussed, although a few such laboratories are well known to be in existence, but British industry has been brought very much together during the past eighteen months and the organization of industry is already a familiar phrase. Why, then, should England not establish a National Industrial Research Laboratory to assist all British manufacturers and to develop the theory underlying the great fundamental industries on which British work depends? Such a laboratory could take the theory from the universities, or where the theory was lacking, develop it and apply it to the separate industries, working out the results on a semi-manufacturing scale and finally passing it on to the manufacturer. It may be of interest to glance at the possible size and scope of such an organization and I have attempted to formulate a scheme which will represent the minimum which would be required.

A laboratory on the smallest scale adequate to British industry would, at the beginning, require a staff of about two thousand men, one thousand of them scientifically trained and the other thousand assistants and workmen. It should have about three or four hundred men of the rank of professor or assistant professor in the universities or of works manager or assistant manager or chief chemist in the factory. It would require land and buildings costing about $3,000,000 and its annual upkeep with allowance for expansion would be about $4,000,000.

Vast as these figures are, they are infinitesimal compared with the value of the industries whom they would serve. They represent a charge of less than one per cent. and probably not more than one fifth per cent. of the net profits of British industry; moreover, after the initial period has been paid for such a laboratory might be self-supporting and might, indeed, finally, make a very handsome profit on the original investment.

Suppose that such a laboratory patented all inventions and licensed manufacturers to use them, then, it is not too much to expect that after the first five or six years it would be paying for itself, and that five years later it would be able to establish a great many subsidiary institutions from its profits; at any rate, such a vast laboratory would produce far more results at lower cost than would result from any other expenditure of a comparable sum of money on industrial research by the British industries.

I believe, however, that within the lifetime of most, if not all, of us we shall see such extensions of industrial research as will make all that we now have in mind seem insignificant, and it is because I believe so strongly in the importance of the subject that I have endeavored to collect some impressions on the subject and to present them in this paper.

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EASTMAN KODAK COMPANY,
ROCHESTER, N. Y.,
February 10, 1916

BENJAMIN FRANKLIN AND ERASMUS DARWIN: WITH SOME UNPUBLISHED CORRESPONDENCE[1]

IT is not generally known that Benjamin Franklin and Erasmus Darwin were correspondents and personal friends. They first met, as far as can be learned, some time during Franklin's second mission to England, between 1764 and 1775, and, attracted to each other by their common scientific interests, a

[1] I wish to acknowledge my deep thanks to Mr. I. Minis Hays, secretary of the American Philosophical Society, for his kind permission to transcribe and publish the correspondence here given.

friendship grew up between them which lasted to the end of Franklin's life. This friendship, after the fashion of the time, found expression chiefly in long letters discussing the scientific views and questions of the day, often accompanied by their own observations or reflections. Darwin, who it should be remembered was Franklin's junior by twenty-five years, was plainly proud of the regard of his famous contemporary, and this feeling is unmistakably reflected in his letters.

In the wonderful collection of Frankliniana[2] in the library of the American Philosophical Society in Philadelphia, there are three autograph letters from Darwin to Franklin, two of them still unpublished. These letters are of great interest for the glimpse they afford into the thoughts and hopes and problems that occupied two such lights of science as these men in the latter half of the eighteenth century.

The earliest of the three letters, and one of the two still unpublished, is dated Lichfield, July 18, [17]72, and is addressed: "Dr. Benjamin Franklin, Craven Street, London." It is remarkable chiefly for one sentence near the end, which contains the amazing information that even as far back as that, someone was puzzling over the idea of making a phonograph. "I have heard," writes Dr. Darwin, "of somebody that attempted to make a speaking machine, pray was there any Truth in any such Reports?"

The rest of the letter is not especially important, and is only interesting as showing the diversity of subjects discussed. Darwin first describes an experiment he performed with "unmix'd air, that rose from the muddy bottom" of a pond, and of which he took home a sample in a bladder and tested it with a lighted candle to see if it would catch fire; which it did not. Then he goes on to say.

I shall be glad at your Leizure of any observations on the Alphabet, & particularly on the number and Formation of vowels, as these are more intricate, than the other Letters.

He then devotes several paragraphs to a discussion of consonant sounds in various dialects as among the Welsh, Northumberland people and others. The letter closes as follows:

I am Sr. with all Respect your obliged & obedt. Servant

E. Darwin

Lichfield, Staffordshire.

I would return you Dr. Priestley's Pamphlet by the Coach but I suppose it is to be purchased at the Booksellers. My friend Mr. Day who saw you at Lichfield intends himself the Pleasure calling of you in London.

A second letter in the collection is a one-page quarto from Darwin to Franklin, dated Lichfield, Jan. 24, 1774. This is the most valuable of all the Darwin–Franklin correspondence extant; it shows Franklin's close relation to the Royal Society of London and also that he read papers before that body for up-country friends. This letter has already been published,[3] but as it has such great general interest, and is so short, it seems worthy of being made more widely known.

Dear Sir,

I have inclosed a medico-philosophical paper which I should take it as a Favour if you will communicate to the royal Society, if you think it worthy a place in their Volume, otherwise must desire you to return it to the Writer.

I have another very curious paper containing Experiments on the Colours seen in the closed Eye after having gazed some time on luminous objects, which is not quite transcribed, but which I will also send you, if you think it is likely to be acceptable to the Society at this Time, but will otherwise let it lie by me another year. I hope you continue to enjoy [. . . torn . . .] Health & that I shall sometime again have the pleasure of seeing you in Staffordshire, & am, dear Sr.

Your affectionate Friend,

Eras. Darwin

N. B. If Dr. Franklin is not in England, I hope the person intrusted to read his letters will return the inclosed papers to Dr. Darwin at Lichfield,

[2] The collection contains 16,678 pieces, or 78 per cent. of all the Franklin papers extant. See preface to "Calendar of the Papers of Benjamin Franklin in the Library of the American Philosophical Society," edited by I. Minis Hays. Philadelphia, 1908.

[3] Jared Sparks' edition of the works of Benjamin Franklin, Vol. VI., page 410, where it is printed with some slight errors in transcription.

Staffordshire, which will be gratefully acknowledged.

The last letter in the collection, also unpublished, is a three-page quarto dated Derby, May 29, 1787. It is addressed simply: "Dr. Franklin, America," and opens in the grandiloquent style of the time, as follows:

Dear Sir,

Whilst I am writing to a Philosopher & a Friend, I can scarcely forget that I am also writing to the greatest Statesman of the present, or perhaps of any century. . . .

I can with difficulty descend to plain prose after these sublime ideas, to thank you for your kindness to my son Robt. Darwin[4] in France, & to converse with you about what may arise in philosophy, which I know will make the most agreeable part of my letter to you.

Then he speaks at length of some electrical experiments performed by a Mr. Bennet, "a Curate in my neighbourhood," who "has found out a method of doubling the smallest conceivable quantity of either plus or minus electricity, till it becomes perceptible to a common electrometer, or increases to a spark."

The end of the letter is interesting and worth quoting in full since it gives the history of the first translation of Linnæus's botanical writings into English.

In respect to other philosophical news, I have just heard from Mr. Wedgewood that Mr. Herschel has discover'd 3 Volcanoes in the Moon now burning.

Since I had the pleasure of seeing you, I have removed from Lichfield to Derby & have superintended a publication of a translation of the botanical works of Linnæus, viz. The System of Vegetables in two volumes 8vo. & the Genera or Families of Plants in 2 vol, 8vo. also.—I did this with design to propogate the knowledge of Botany. They are sold to the booksellers at 14/ the System of Vegetables—the Genera will be finished in a month, & will be sold to the booksellers at 12/ I believe,—but as we are to pay for advertizing & carriage, I expect we shall not clear more than 10/ on each set. If the work had been finished I should have sent you it by the favor of Mr. Nichlin, who is so kind as to take the care of this letter. If I thought 20 sets of each were likely to be sold I would send them at 10/ a set of each, that is 20/ for the four volumes. And indeed would now have sent them by Mr. Nichlin, had the whole been ready, as I think they would not be worth reprinting in America, & perhaps 20 sets would be as many as could find purchasers.

A Line from you at your leizure, only to acquaint me that you continue to possess a tollerable share of health would be very acceptable to, dear Sr. with true esteem

Your most obed. ser.

E. DARWIN

[4] The father of Charles Darwin.

L. HUSSAKOF

AMERICAN MUSEUM OF NATURAL HISTORY

SVEN MAGNUS GRONBERGER

SVEN MAGNUS GRONBERGER, of the library staff of the Smithsonian Institution, died at Georgetown University Hospital, Washington, on April 24, after an illness of about three weeks. He leaves two older brothers and a nephew, resident in Stockholm, Sweden; his estate he bequeathed to this nephew.

Mr. Gronberger, who was a native of Sweden, born August 19, 1866, was graduated in 1884 from the gymnasium of Norrköping, an historic old city on the Baltic about seventy-five miles south of Stockholm. In 1886, after visiting France and England, he went to New York City, where he studied law and in 1907 came to Washington. As a student of natural science he was preparing for the degree of Doctor of Philosophy at George Washington University, with topics zoology and geology, in which subjects he had published several papers, and articles in *Forest and Stream*. He was an accomplished linguist, knowing perfectly French (which was his home language as a member of the nobility of Sweden, his mother being a countess) and the Scandinavian tongues, including some Icelandic, and being versed also in English, German, Italian and other European languages and literatures, besides Latin and Greek. For a number of years Mr. Gronberger made a special study of zoological parks as factors in the popularization of natural science, especially in connection with the Bronx Zoological Park of New York and the National Zoological Park at Washington. He was a member of the Biological

Society of Washington, the Anthropological Society of Washington, the American Ornithological Union, the Audubon Society, and the Writers Club of Washington.

Mr. Gronberger wrote an exhaustive monograph on the "Palearctic Birds of Greenland," the first thorough study attempted of the subject, being a review of the occurrence of European and Asiatic species in Greenland from the middle of the eighteenth century to the present time, publication of which is in charge of the United States National Museum. He published a study of "Birds near Washington," in *Forest and Stream*. A paper by him on "The Origin of the Goths" deals with the Gothic migration from Scandza, or Scandinavia, as described by Jordanes and the corrobating evidence of a celebrated runic inscription in Sweden; probably to be brought out in Stockholm. Publication of a recent study of the Batrachia Salientia or Anura of the District of Columbia is in charge of the National Museum. He left also a life of the religious mystic, "Saint Bridget [Brigitt] of Sweden," based on the best historical sources available. An address by Mr. Gronberger on "Modern Swedish Literature" will be published by the Writers Club of Washington, with a biographical sketch and portrait of the author.

F. E. Fowle

SCIENTIFIC NOTES AND NEWS

Dr. Edward S. Morse has been reelected president of the Boston Society of Natural History.

Under the retiring clause in the faculty regulations of Stanford University, Dr. David Starr Jordan has, as has already been noted in Science, been made chancellor emeritus; Dr. Oliver Peebles Jenkins has been made professor emeritus of physiology and histology, and Dr. Lillian Jane Martin, professor emeritus of psychology.

Sir T. Clifford Allbutt, regius professor of physics at the University of Cambridge, has been nominated by the council to be president of the British Medical Association. On account of the war the annual meeting at Cambridge will be postponed, but the statutory general meeting will be held in London, on July 28.

We regret to learn that Professor Elie Metchnikoff, head of the Pasteur Institute at Paris, France, who has been ill since January with heart trouble has become worse.

Professor Wm. Bullock Clark, head of the department of geology at the Johns Hopkins University, has been appointed by the Chamber of Commerce of the United States a member of a committee of five to discuss with the representatives of organized labor a modification of the anti-trust laws by which cooperative agreements under the regulation of the Federal Trade Commission might be allowed in those industries dealing with the primary natural resources.

At the annual dinner of the Geological Journal Club, of Columbia University, on May 17, the students and members of the departmental faculty presented to Professor Amadeus W. Grabau a copy of Suess's "The Face of the Earth," in commemoration of the completion of fifteen years of active service as a teacher in Columbia University and as a philosophical student of geology. Mr. S. H. Knight, fellow in paleontology, made the presentation. Professor Grabau also received an anonymous gift of $150 from a former student for the furtherance of his research in stratigraphy and paleontology.

Professor August von Wassermann, head of the Royal Institute for Infectious Diseases at Berlin, will become director of the Institute for Experimental Therapy at Frankfort, in succession to the late Professor Paul Ehrlich.

Dr. F. F. Martinez, who has published several works on tropical medicine, has been appointed director of the newly organized Institute of Tropical Medicine at Granada.

Dr. William Palmer Lucas, San Francisco, professor of pediatrics in the University of California Medical School, has gone to Europe to aid in the organization of children's work for the American Commission for Relief in Belgium.

PROFESSOR EDWARD W. BERRY, of the geological department of the Johns Hopkins University, will do work in Mississippi and Texas for the U. S. Geological Survey during the coming summer.

THE British Science Guild held its annual meeting on May 17, when an address was given by the Hon. Andrew Fisher, high commissioner for the commonwealth of Australia, on "The Establishment of a National Institute of Science and Industry in Australia."

WITH the aid of a grant from the National Geographic Society Dr. Robert F. Griggs, of the Ohio State University, will continue this summer his researches in the Katmai District of Alaska. He hopes to explore the hitherto unvisited volcanoes of the district but will devote his attention primarily to a study of the revegetation of the region devastated by the great eruption of Mt. Katmai in 1912.

ABNER HOWARD POWERS, professor of surgery in the school of medicine of Boston University, died on May 13, aged sixty years, from injuries received in an automobile collision.

DR. JAMES ROBERT JONES, professor of theory and practise of medicine in Manitoba Medical College, Winnipeg, has died at the age of sixty-seven years.

DR. M. STRAUB, professor of ophthalmology at the University of Amsterdam, has died, aged fifty-seven years.

PROFESSOR H. P. WIJSMAN, who held the chair of toxicology at Leyden, died on March 19.

M. JULES GOSSELET, professor of geology at Lille from 1865 to 1902, died at Lille on March 20, aged eighty-four years.

THE death is announced of E. Jungfleisch, professor of organic chemistry at the College of France, with a chair also at the Academy of Arts and Trades.

THE Indiana Academy of Science is holding its spring meeting at Valparaiso, on June 1, 2 and 3, as guests of Valparaiso University and the local members.

THE Maryland Geological Survey will have a number of parties in the field during the summer gathering data for systematic reports on the Silurian and Carboniferous formations, economic reports on the coals and fire clays, and on the underground waters. The following instructors and graduate students of the Geological Department will be engaged in this work: Professor Swartz and Dr. H. Bassler will be in the Silurian and Carboniferous region of western Maryland. G. M. Hall will be at work gathering materials for a report on the fire clays of the state. W. A. Baker will gather data regarding the equipment of the coal-operating companies for a report on the Coals of Maryland. J. P. D. Hull will spend part of the summer mapping the soils of Howard County and the balance in working on the geology of the Piedmont area of the same county. H. Insley will work on the Piedmont area of Harford County and on the underground waters of the northeastern tier of Piedmont counties. D. G. Thompson will work on the underground waters of portions of central and western Maryland.

THE Biological Station maintained by the University of Michigan at Douglas Lake, Michigan, will be opened for its eighth season from July 3 to August 25. The laboratory is provided with all the apparatus usually found at summer stations, but possesses also a considerable amount of equipment not ordinarily found elsewhere. The purpose of the institution is to provide instruction and facilities for research in animal and plant ecology under conditions as nearly natural as possible. For the coming session the zoological part of the program includes studies on the ecological relations of the aquatic vertebrate and invertebrate fauna, insects, birds and parasites, whereas the botanical courses will deal with forest botany, plant anatomy, general systematics and ecology. In addition to these more or less formal courses, students may elect special work adjusted to their individual needs. Independent investigators and others who desire to make use of the station are invited to communicate with the director at the University of Michigan.

WE are requested by the Surgeon-General of the Navy to print the following statement:

"Among the various items of increase in national preparedness which it is hoped will be afforded by the present session of Congress is that authorizing an appropriate increase in the personnel of the military services. One item of interest to the medical profession of the country is that calling for an increase in the medical corps of the Navy from its present strength of 347 to approximately 500. The openings at present afforded young graduates in medicine for entering the medical corps of the Navy will be materially increased in prospects and rewards, therefore, if such an increase is provided. An examination will be held on June 19 next, for appointment in the medical corps to vacancies already existing. A candidate for appointment must be between twenty-one and thirty years of age, a graduate of a reputable school of medicine, and must apply for permission to appear before an examining board. These boards are convened at various places over the country, and assignments to such boards are arranged to suit the convenience of the candidate. Duty in the medical corps of the navy is one that affords plenty of rewards to the ambitious worker, as well as attractions of a varied nature in personal and professional work. Pay begins at the rate of $2,000 per annum, with ample allowances, and promotion and increase in pay and allowances follow every few years. It is hoped that the young men of the United States will take advantage of this attitude of the nation, now on the threshold of expansion in national ideals of preparedness, and find in the service of their country an outlet for their future life work. For detailed information as regards the coming examination on June 19, 1916, applicants should address the Surgeon-General, U. S. Navy, Navy Department, Washington, D. C."

Radium, uranium and vanadium are closely connected in occurrence in the principal fields, Colorado and Utah, but in 1915, although the European war caused a great slump in the production of ores of radium and uranium, it caused a considerable increase in the production of ores of vanadium. According to reports for 1915 received by the United States Geological Survey and compiled by Frank L. Hess the output was 23.4 tons of uranium oxide and 6 grams of radium contained in the carnotite ores produced, and 635 tons of vanadium contained in the carnotite ores shipped and in the chemical concentrates from the roscoelite ores. In 1914 the ores produced contained 87.2 tons uranium oxide, 22.3 grams radium, and 435 tons vanadium. The United States has much the largest known radium-bearing deposits of the world, but the market for radium is mostly in Europe, for, though Americans like to feel that they are sufficiently progressive to take hold of and use to the full new discoveries, inventions and processes, yet the European municipalities and hospitals have been buying and utilizing most of the radium produced. When the war began, therefore, causing European money to flow into other channels the demand for radium fell off so greatly that there was practically no market for radium or uranium ores in the early part of 1915, and very little market during any part of the year. Mining of carnotite ores, except by the National Radium Institute (Inc.) under the supervision of and in cooperation with the Bureau of Mines, and except for such work as was necessary for assessment work to hold claims, was nearly stopped. The institute mined nearly the 1,000 tons of ore contracted for from the Crucible Steel Mining & Milling Co.'s claims in Long Park, Montrose County, Colo., and obtained 70 tons of concentrates, carrying about 3 per cent. of uranium oxide, by concentrating material carrying 0.7 per cent., which had been thrown on the dumps. The institute fully accomplished its purpose to work out a practical process of producing radium at a cost much below the market price of the element and crystallized out radium salts containing 6 grams of the element. It delivered during the year 3.006 grams of radium (element) at a cost of $37,599 per gram. Near the close of the year 1.1 grams of radium (element) was contracted for by a private company for $132,000, or $120,000 a gram. This comparison shows the great success of the work of the Bureau of

Mines. Its ore concentration method seems to have also been highly successful. After mining its quota of ore from the Crucible Steel Mining & Milling Co.'s property, the institute came into the market as a purchaser of ore. In the later half of the year Dr. W. A. Schlesinger and associates established a radium reduction plant in Denver. They acquired an interest in the Copper Prince claims, from which ore was mined, and bought a further quantity. Ore carrying about 5,000 pounds of uranium oxide, containing about 640 milligrams of radium, was treated during the year. The Carnotite Reduction Co., made up of Dr. H. N. McCoy of the University of Chicago and associates, purchased from Galloway and Belisle a quantity of ore which had been stored in Placerville, Colo., and the radium will be extracted in Chicago. The company will mine ore from claims it has bought. The Standard Chemical Co. did no work on its claims except that required by law, but in this work produced and shipped a quantity of ore from its properties in Colorado and Utah, and purchased, it is stated, a considerable number of claims. It was reported in December that the company had produced a total of 14 grams of radium (elemental) and that its ore had averaged 1.7 per cent. uranium oxide. Probably between 4 and 5 grams of this quantity were produced during 1915. The production of radium salts in this country during the year was probably nearly 11 grams.

MR. BARNUM BROWN returned to the American Museum of Natural History in January, bringing a carload of fossil dinosaur bones, chiefly from the Belly River Cretaceous formation of Alberta. The collection comprises two complete skeletons; one of the horned dinosaur *Ceratops*, of which the museum previously possessed only skulls; the other of the helmeted dinosaur *Stephanosaurus*, not before represented in the museum's collection. Other notable specimens are a complete skull and jaws of the horned dinosaur *Monoclonius;* a skull and part of the skeleton of an armored dinosaur; and the largest skull yet discovered (five feet in length) of the duck-billed dinosaur, *Trachodon*. Another very rare specimen is a complete lower jaw of a cretaceous marsupial mammal. In addition to the vertebrate remains, two large silicified tree trunks were secured, over forty feet in length. When these are sectioned it will be possible to determine the genus to which they belong. They are of especial interest because the center of the tree is silicified, while surrounding it the outer portion had carbonized, forming lignite. Several large slabs were also obtained on which impressions of many species of leaves are beautifully preserved. This material will be displayed to show the type of foliage contemporaneous with the dinosaur life of Alberta. After bringing to completion the museum's work on the Red Deer River, which has extended over a period of six years and been productive of four and a half carloads of valuable fossils, Mr. Brown went to Northern Montana. Here he secured a large collection from the Upper Cretaceous beds on Milk River. Work was continued in this field until zero weather compelled cessation of operations.

THE Philadelphia Academy of Surgery announces that essays for the Samuel D. Gross prize of fifteen hundred dollars will be received until January 1, 1920. The conditions are that the prize "shall be awarded every five years to the writer of the best original essay, not exceeding one hundred and fifty printed pages, octavo, in length, illustrative of some subject in surgical pathology or surgical practise, founded upon original investigations, the candidates for the prize to be American citizens."

UNIVERSITY AND EDUCATIONAL NEWS

DR. JOHN C. DUNCAN has been appointed professor of astronomy and director of Whitin Observatory of Wellesley College. Professor Sarah F. Whiting retires at the close of the present academic year as does also Professor Ellen Hayes. Professor Whiting, a pupil of Professor E. C. Pickering at the Massachusetts Institute of Technology before he became director of Harvard Observatory, gave the first lectures in astronomy at Wellesley College in

1879, as a course in applied physics. A portable four and a half inch telescope was the only available instrument until 1900, when the beautiful Whitin Observatory equipped with twelve-inch telescope, three-inch transit, all necessary apparatus, and an adequate library in astronomy was opened, through the generosity of Mrs. John C. Whitin, a trustee of the college. In 1906 the observatory was doubled to make room for the teaching of astronomy as other sciences are taught by the laboratory method, and a residence for the astronomers was added. Professor Hayes, head of the department of applied mathematics, a pupil of Ormund Stone, meantime conducted work in mathematical astronomy. In 1901 the department of astronomy was created, including both the astrophysical and the mathematical sides of the subject. Dr. Duncan has worked at Lick, Lowell and Yerkes observatories, and has taught at Harvard and Radcliffe Colleges.

Frank H. Probert, a graduate of the Royal School of Mines in London, and for the past twenty years engaged in consulting mining engineering practise, has been appointed professor of mining in the University of California, as successor to the late Professor Samuel Benedict Christy.

Dr. Jesse F. Williams, assistant professor of hygiene and physical education at Columbia University, has been appointed professor of hygiene and physical education in the University of Cincinnati.

Dr. Henry W. Wandless has been appointed clinical professor of ophthalmology at New York University and Bellevue Hospital Medical College.

Dr. Edward H. Horton, director of the bacteriologic department of the Tri-Cities Hygienic Institute, LaSalle, has resigned to become bacteriologist in the Northwestern University Dental College, Chicago.

Dr. Sterling Temple, instructor in chemistry in the University of Minnesota, has accepted a position as professor of chemistry at Hamline University, and will take up his work there in the autumn.

At Ohio Northern University, Joseph Hamilton Hill has become professor of mathematics.

Sir R. Havelock Charles, president of the medical board of the India Office, has been appointed dean of the London School of Tropical Medicine in succession to the late Sir Francis Lovell.

DISCUSSION AND CORRESPONDENCE

A NEW FORM OF PLANT DRIER

A number of notices have been published[1] regarding the use of single or double-faced corrugated straw board as a means of rapid drying of plants for herbaria. Some have omitted the use of the customary driers with the corrugated boards, a procedure which has a tendency to cause the plants to be somewhat wrinkled. It has also been recommended that the boards be cut so that the corrugations run crosswise of the board. The pressure of the straps around the press, however, has a greater tendency to close up the ends of the corrugations when they run crosswise than when they run lengthwise. To avoid handling two driers and a corrugated board for every plant placed in press the writer adopted the plan several years ago of fastening at the corners with a wire stapling machine two driers with a corrugated board between. This procedure saves two thirds of ones' time in handling the corrugated boards and two driers in the old way. While this form of drier worked very satisfactorily when hot sunshine or artificial heat was available for drying it made the drying material much thicker than necessary. An order was consequently given to a local firm for a special drier consisting of two pieces of ordinary felt drying paper with a corrugated filler such as is used in the single and double-faced corrugated straw board. This material has given entire satisfaction and can be obtained in large quantities at a cost of about $16.56 per 1,000 as compared with

[1] Kellerman, W. A., Science, N. S., 27: 67–70, 1908; Collins, J. F., *Rhodora*, 12: 221–224, 1910; Conrad, H. S., *Plant World*, 15: 135–139, 1912; Ricker, P. L., Bureau of Plant Industry Circ., 126: 27–35, 1913.

$10 per 1,000 quoted by one firm for medium weight and $14 per 1,000 for heavy weight driers. When it is considered that a large part of the material pressed under the old system, using blotters alone, required the use of two blotters between each specimen, it will be seen that a considerable saving is effected in the cost of the drying material as well as in the time required to handle and completely dry the material.

P. L. RICKER

BUREAU OF PLANT INDUSTRY

A NEW COLOR VARIETY OF THE NORWAY RAT

NORWAY rats with dilute coat color have recently been taken in the vicinity of the University of Pennsylvania. If we may judge from the fact that the nine individuals thus far found are all approximately alike and are distinctly different from the normal type, they probably represent a new Mendelian variety.

The coat is intermediate in color between that of the ordinary dark form and the albino and resembles that of the red-eyed guinea pig. In the guinea pig this color has been shown by Wright to be allelomorphic with albinism and with dilute. As in the guinea pig, the hair of the new rat seems to be without yellow pigment and is dilute black or brown ticked with white.

The eyes look black unless the light is very bright. When the light shines directly into them they appear pink. They are distinctly lighter than the eyes of Castle's red-eyed yellow rats, but darker than those of his pink-eyed yellows.

The new rats are now in the care of the Wistar Institute, where the endeavor is being made to increase the stock and to cross with the color varieties already known.

Data in regard to the distribution of the new form is being collected and will later be published.

The previously known Mendelian varieties in the rat are five: black, hooded, albino and Castle's two yellow varieties, red-eye and pink-eye. This new variety is a non-yellow dilute and may be called ruby-eye.

PHINEAS W. WHITING

UNIVERSITY OF PENNSYLVANIA

SYLVESTER AND CAYLEY

UNDER the portrait with which the editor has adorned my article "Sylvester at Hopkins," in *The Johns Hopkins Alumni Magazine* of March, 1916, the designation is simply "James Sylvester."

This omits his real name, his family name, the name to which he was born; for his father was Mr. Abraham Joseph, his two sisters were the Misses Joseph. The name by which we know him he chose for himself, following the example of his eldest brother, who early in life established himself in America and assumed the name of Sylvester.

My laborious and critical friend, Professor G. A. Miller, of the University of Illinois, in his recent book "An Introduction to Mathematical Literature," commits the colossal error of representing Sylvester and Cayley as friends together at college, Cambridge chums, whereas Sylvester entered Cambridge in 1831 and Cayley was senior wrangler at Cambridge in 1842, more than a decade later. Sylvester had already in the session 1837–38 been appointed professor in London University College, and it was in London, but only after the lapse of nearly another decade, in fact in 1846, that Cayley met Sylvester.

GEORGE BRUCE HALSTED

GREELEY, COLO.

SCIENTIFIC BOOKS

Indian Mathematics. By G. R. KAYE. Calcutta & Simla, Thacker Spink & Co., 1915. Pp. 73.

Of all the British writers on the history of Indian mathematics at the present time, none is better known or more serious in his purpose than Mr. Kaye. A scholar by nature and, through his connection with the Indian service, placed in an environment which is conducive to the study of the original sources, few men have the opportunities which are his for bringing the mathematical learning of the East to the knowledge of the West.

This being the case, the reader might naturally expect to find in a publication with such a title as this an exhaustive and well-

balanced treatment of the general field of native Hindu mathematics. In this anticipation he will, however, be disappointed. Mr. Kaye's mind runs rather to monographs than to treatises, and these monographs are generally of real value to those who are less fortunately situated with respect to the sources of information. But in the present instance he has given us a monograph with a rather pretentious title which does not seem quite worthy of his undoubted powers. It is, of course, characterized by Mr. Kaye's prejudice against any claims of originality on the part of the Hindu scholars, but this feature is rather less obtrusive than in his other monographs, and in any case a reader can overlook a bias of this kind if he is presented with the evidence in such a fashion as to allow of its being weighed by himself. But the work is by no means an exhaustive presentation of Indian mathematics and it contains but little that is not already familiar to the students of history.

Mr. Kaye divides the subject into three historic periods: (1) the S'ulvasūtra period, extending to about A.D. 200; (2) the astronomical period, extending from about A.D. 400 to 600; (3) the Hindu mathematical period proper, extending from A.D. 600 to 1200, after which there was no native mathematics worth mentioning.

The word S'ulvasūtra means "the rules of the cord," and applies to certain verses treating of the construction of altars. The connection with the Egyptian "rope-stretchers" (harpedonaptæ) will occur to every one who has considered the history of ancient geometry, and, like so many parallels of this kind, is suggestive of the early intercourse between the East and the West. The dates of the S'ulvasūtras are uncertain, and the manuscripts show many variations due to different scribes, but we know to a certainty enough about them to render their study of interest in the history of mathematics. The Pythagorean theorem is stated with some generality, although there is nothing to show whether it was an independent product of India, or came from China, where it seems to have been already known, or worked its way eastward from the Mediterranean civilization, perhaps at the time of the visit of the forces of Alexander. The unit fraction is in evidence, as it was in Egypt and Babylon two thousand years earlier. The mensuration of the circle is also a feature of the S'ulvasūtras. The most interesting suggestion made by Mr. Kaye in this connection relates to a circle of diameter d and area a^2, namely, that the relation

$$d = a + \tfrac{1}{3}(a\sqrt{2} - a),$$

which is given in the editions of Āpastamba and Baudhāyana, led to the relation

$$a = d\left(1 - \frac{1}{8} + \frac{1}{8.29} - \frac{1}{8.29.6} + \frac{1}{8.29.6.8}\right)$$

through the substitution for $\sqrt{2}$ of

$$1 + \frac{1}{3} + \frac{1}{3.4} - \frac{1}{3.4.34},$$

which value is given earlier in the S'ulvasūtras. Mr. Kaye asserts, however, that this substitution was beyond the powers of the Hindu mathematicians of that period, and it is a fact that we have no other evidence of any ability to make such a substitution.

As far as our present knowledge goes, there is a gap between the S'ulvasūtra mathematics and the first distinct treatises on the subject, such as the Sūrya Siddhānta, the anonymous astronomical classic of about A.D. 400. This work was included in the great collection made by Varāha Mihira in the sixth century, and the evidence seems to show that, by this time, more or less of Greek mathematics was known in India. Ptolemy's influence seems to be evident in the table of chords given by Varāha Mihira, but the earliest known use of the sine occurs in the Hindu works of this period.

Mr. Kaye summarizes the work of Āryabhaṭa in a satisfactory manner, making no mention of the younger mathematician of the same name to whom he devoted some attention a few years ago. Indeed, his statement that "the Indian works record distinct advances on what is left of the Greek analysis" is perhaps the most outspoken statement in favor of the Hindu algebraists to be found in any of his writings.

Noteworthy among the special topics studied by Mr. Kaye are the Hindu methods of solving the equation $Du^2+1=t^2$, beginning with Brahmagupta in the seventh century, together with a conspectus of the indeterminate problems dealt with in India. The problems of the rational right triangle and the value of π, attractive ones to the Hindu writers from Brahmagupta on, are also studied by Mr. Kaye and two helpful synopses are given. A brief study of the connection between Chinese and Hindu mathematics is also given, and the proof which is adduced seems to be valid that Mahavir, in the ninth century, was acquainted with certain Chinese works. This acquaintance appears, for example, in the treatment of the area of a segment of a circle and in two or three applied problems. It is doubtful, however, if this relationship and others like it are sufficient ground for the sweeping assertions contained in the following statements:

> That the most important parts of the works of the Indian mathematicians from Aryabhaṭa to Bhāskara are essentially based upon western knowledge is now established. A somewhat intimate connection between early Chinese and Indian mathematics is also established. That the Arabic development of mathematics was practically independent of Indian influence is also proved.

It would be safer to say that the solution of the problem of the relationship between the scholarship of the East and that of the West has hardly yet been begun.

Two helpful features of the work are the large number of extracts from the original treatises, and a fair bibliography. Mention should also be made of two interesting photographic reproductions, one of two pages of Śrīdhara's *Trisátikā* and the other of three pages of the Bakhshālī manuscript. There is also a helpful index to the work.

The book, small though it is, should be on the shelves of all who are interested in Oriental mathematics. It is to be hoped that Mr. Kaye will some time prepare a more exhaustive work upon the subject.

DAVID EUGENE SMITH

Assaying in Theory and Practise. By E. A. WRAIGHT, of Royal School of Mines, London. Longmans, Green and Co. Pp. 316. 86 figures in text. $3.00.

The text of the book is divided into four parts. *First:* Numerical Data, Laboratory Plans, Lists of Apparatus, Minerals and Their Characteristics. *Second* Part: Dry Assaying; contains chapters on tests for recognition of various metals, sampling, general assay problems and methods of assay for tin, gold, silver, lead, mercury, fuels and refractory materials. *Third* Part: Wet methods for iron, copper, zinc, aluminum, lead, bismuth, tin, tungsten, arsenic, antimony, manganese, chromium, sulphur, vanadium, cobalt, nickel, uranium and molybdenum. *Fourth* Part: Control tests for cyaniding solutions and cyaniding methods.

It is rather doubtful whether any one, who was not fairly well grounded in chemistry and chemical manipulation, could make much progress in assaying by the use of the book alone. The methods given leave much to the mind of the reader. In the tests for recognition, a wet and a dry test are given for each element. No mention is made of the influence of other elements which may hide the test entirely. In the description of grinding no mention of the mechanical grinders is made. The iron mortar and the backing board are recommended, notwithstanding the fact that some form of mechanical grinder is found in almost every assay laboratory.

Gas furnaces and oil furnaces are also omitted from the description. These furnaces may not be in common use in England, but they are found everywhere in this country.

The reviewer does not agree with some of the methods recommended, but that is perhaps only a difference of opinion.

But one form of calorimeter is described, but the principles of calorimetry are well described.

The book furnishes much in a suggestive way and may be taken as a good outline for a course in assaying, but the course would have to be supervised by a competent instructor.

OWEN L. SHINN

MOSQUITOES AND MAN

A UNIQUE deduction, and one likely to be of great value to sanitarians has been reached as one of the results of the work done in the Canal Zone by Major P. M. Ashburn, Medical Corps, U. S. Army. As general inspector, health department, Canal Zone, Major Ashburn became intimately acquainted with the breeding conditions there, and one result of his observation may be summed up in his statement "*the malarial mosquito follows man.*" This means also that their breeding places are normally within convenient reach of human habitation and becomes a very effective as well as an entirely new viewpoint of already recognized conditions, and a viewpoint it would be wise to keep in mind wherever health, efficiency and mosquito control are to be considered.

Major Ashburn in referring to the well-proven flight of anophelines of "more than a mile from their place of breeding" draws attention to the facts[1] that there is at this particular location "a large area where the conditions for breeding are unusually favorable . . . an enormous amount of breeding . . . lack of abundant human blood for food in the neighborhood of the breeding place, *the presence of abundance of food* (a town) at a distance of a mile," and goes on to say "were there another town within two hundred yards or a quarter or half of a mile, the chances are that the town a mile away would scarcely notice any change in the number of mosquitoes." "In fact such has been the experience at several places on the Isthmus," and, referring to another location adds: "The conditions favored a big flight, but a human barrier in the neighborhood served to check it and make the increase of mosquitoes merely a local one."

In another paper[2] Major Ashburn speaks of the conditions in the Canal Zone where places that had been "great hot beds of malaria, and great breeding places for *Anopheles albimanus*, now, since their depopulation, have very few or no *Anopheles*" mentioning the water works at Miraflores, Cocoli, Ancon Village as examples and refers to a few instances where *Anopheles* which "were supposed to have come from considerable distances, the situations were found controllable by intensive effort expended close at hand," while the hydraulic fills at several places which gave rise to much increased breeding did not give rise to flights of great length, because "there was food nearer at hand."

Naturally the interposition of "an animal barrier between extensive *Anopheles* breeding places and human habitation" was considered, but this was found to have already been proven of small or no value.

Major Ashburn then evolved an hypothesis including "(*A*) *Parasitism*, (*B*) *Long Flights*, (*C*) *Anopheles breeding far from man not malarial carriers.*" It is with the last point we are most concerned, although, of course, the three parts are really interdependent.

Major Ashburn calls attention to the fact that *Anopheles apicimaculatus*, not a malaria carrier, was often found breeding 800 yards from human habitation, and that even a temporary construction camp of a large gang of negroes was enough to bring malaria carriers to a given place, and the removal of the laborers was followed by a discontinuance of the breeding of malaria carriers at that place.

Finally, at a contractor's camp, established November 26, 1913, at Caño Saddle, in a previously uninhabited location, hand catching of mosquitoes showed an increase in the weekly takings of malaria carriers as indicated in the following partial table:

Week Ending	Malaria Carriers
December 6, 1913	6
December 13, 1913	34
December 20, 1913	165
December 27, 1913	115
January 31, 1914	1,211
March 7, 1914	3,277
May 9, 1914	87

[1] Ashburn, P. M., Major, Medical Corps, U. S. A., "Elements of Military Hygiene," 2d ed. (1915), pp. 285.

[2] Ashburn, P. M., Major, Medical Corps, U. S. A., general inspector, health department, Panama Canal, "Some Observations Bearing on the Control of Malaria." Read before the Canal Zone Medical Association, late in 1914.

After which, at the approach of the dry season, and the discontinuance of the camp early in May the numbers gradually lessened.

So far as the incidental appearance of malaria is concerned, while Major Ashburn says the reports are perhaps unduly favorable, the first case was sent into hospital February 7. In December, shortly after the opening of the camp it was inspected and malaria was predicted, but was not then present; in February two cases were reported, by the last of March the percentage on blood examination had risen to 20 per cent., and in April to 100 per cent.

It is to be noted that these *Anophelines* "did not greatly abound until after the laborers had been at this location for three weeks or more, and malaria made no headway until after two months."

From these observations Major Ashburn concludes, although for very different reasons than the usual ones of ability in length of flight, that "in ordinary sanitary practise, and not considering such exceptionally large and favorable breeding places, the control of all breeding within four hundred yards of towns, posts and houses serves to make them fairly comfortable and safe residences."[3]

It is however the difference in reasons that makes Major Ashburn's conclusions of especial value, and the whole of Major Ashburn's paper is well worth study. It throws an absolutely new light on the subject, gives a valid reason for the acknowledged limit of four hundred yards as the usual flight of *Anopheles,* and clears up some points in mosquito control that have hitherto been obscure and bewildering.

C. S. LUDLOW

ARMY MEDICAL MUSEUM,
WASHINGTON, D. C.,
May 4, 1916

SPECIAL ARTICLES

THE ORIGIN BY MUTATION OF THE ENDEMIC PLANTS OF CEYLON

IN a recent paper Dr. J. C. Willis has made a statistical study of the flora of Ceylon in order to show that the indigenous species of this island must have been developed by mutation and without any kind of advantageous response to local conditions.[1]

It is obvious that the mutation theory wants in the first place a study of those facts which may throw a direct light on the evolution of wild species and that only relatively young forms have a sufficient chance of still living under the same or almost the same conditions, under which they originated. The material, afforded by the flora of Ceylon, is exceptionally rich in this respect and thoroughly well prepared by numerous investigators and especially in the great "Flora of Ceylon" by Trimen and Hooker.

Ceylon is a comparatively small island (25,000 sq. miles) and has a flora of 2,809 species of Angiosperms, of which 809 are endemic to the island.

Moreover of the 1,027 genera to which those species belong, 23 are confined to Ceylon, and among the 149 families, this is the case with six. Among the endemic genera 17 are represented by one species only, four by 2–3 and only two by a large number. These latter are *Doona* with 11 and *Stemonoporus* with 15 species, almost all of which are very rare forms, but distinguished from one another by characters of full specific rank. They give the impression that they may have been formed by what *Standfuss* has called explosive methods, a number of new species being produced almost at the same time.

As a rule, the endemic species are rare or very rare. More than a hundred of them are confined to one mountain top or to some very small area in the mountains.

Many of these occur as a very few individuals, say a dozen or little more, and the places where they can thrive are so small that it is obvious that they can never have been much more numerous. They must have evolved on the spot where they are found. Notwithstanding this, they are well-marked Linnean species and accepted as such by Trimen and Hooker. Not rarely their distinguishing characters are relatively large.

[3] Ashburn, P. M., "Elements of Military Hygiene," 2d ed. (1915).

[1] J. C. Willis, "The Endemic Flora of Ceylon, with Reference to Geographical Distribution and Evolution in General," *Phil. Trans. Roy. Soc. London,* Series *B,* Vol. 206, pp. 307–342.

In drawing such conclusions, however, even from a thorough knowledge of a flora, one is often exposed to lay too much stress on striking but exceptional instances, whereas it is only averages which may really be relied upon. For this reason Willis has worked out a method, which gives a large degree of accuracy and thereby affords a firm and unattackable basis for his deductions. Trimen divides all species into six classes: Very Common, Common, Rather Common, Rather Rare, Rare and Very Rare, and his estimates are thoroughly reliable, as is shown by the clearness and regularity of the results derived from them.

In order to compare two or more groups of species Willis multiplies the number of species in them, belonging to each of these classes by a factor indicating the degree of rarity according to the estimates of Trimen. These factors are 1 for very common, 2 for common and so on, up to 6 for very rare. In this way averages may be calculated, which give the relative degree of rarity for any group under consideration.

Next, the plants of Ceylon are divided into three main groups, one containing the endemic species, the second those confined to Ceylon and Peninsular India, and the third the forms of wider (although often not very much wider) distribution. In this way Willis finds:

	No. of Species	Rarity
Mean rarity of all species ..	2,809	3,5
Species of wide distribution.	1,508	3,0
Of Ceylon and Peninsular India	492	3,5
Species endemic to Ceylon...	809	4,3
Species of all 23 endemic genera	52	4,5
Species of *Doona* (endemic)..	11	4,6
Species of *Stemonoporus* (endemic)	15	5,4

Thus the species of wide distribution are the commonest, those of Ceylon and India have just the mean degree of rarity, but the endemics are relatively rare, the rarest of all being the species of the endemic genera and especially those of the only two genera which are rich in endemics. Results of the same kind, obtained by applying this method to different manners of bringing the species of this island into groups, are given in numerous tables, the study of which will be of great importance to all scientists interested in the subject.

One of the main results is that the variation in rarity between the different families or groups of families of Ceylon-endemics is small, and goes to show that no one family has any particular advantage over another. In comparing the genera with one another the same rule prevails, independent of the question which genera are chosen and from which point of view the comparison is made.

The order of rarity: Ceylon, Ceylon and Peninsular India, Wider Dispersal, holds throughout all comparisons with extraordinary regularity. It is obvious that some general law must be underlying these phenomena.

If the endemic species had originated by natural selection of infinitesimal steps and in response to the local conditions, which are obviously the only conditions that matter when the species first appears, they must have been, from this very origin, better adapted to these conditions than their parent species. According to the theory of natural selection it would follow that they must surpass their forerunners in the struggle for life and soon spread to a higher degree of commonness. But as the table shows, the reverse is true. Yet they have had ample time even for gaining a comparatively wide dispersal. Several recently introduced species have spread to the stage of very common, often in a few years. *Tithonia diversifolia*, one of the Compositæ, began to spread about 1866 and in 1900 was all over the island in damp enough spots. *Mikania scandens* began to spread ten years ago and is already common all around Peradeniya. Many other instances could be given, since about 60 introduced species have become more or less common in the island.

Of the 809 endemics of Ceylon only 90 are now common and only 19 very common in the island, the remainder are mostly rare or very rare. If they did not conquer their parents and spread into larger areas, it is obvious that they were not especially adapted to the condi-

tions prevailing in the island, and at least not better adapted than the species from which they sprung. Or, in other words, that they did not originate in advantageous response to those local conditions. A large amount of facts and considerations has been brought forward by the author in order to justify this conclusion.

These conclusions provide us with a strong argument against the hypothesis of a slow and gradual evolution by small and almost invisible steps, and for the theory of their production by mutations. In the rare cases of rapid dispersal of new species a better adaptation may of course be assumed as one of the chief factors, but on the average the dispersal is very slow in the beginning, giving no argument in favor of this view.

Furthermore these considerations lead to the view that wide distribution and commonness are chiefly dependent on age, and only rarely on adaptation. In every family the genera with the widest distribution may be considered as the oldest, those with a smaller domain as younger, and the local endemics as the youngest of all. These principles will be used in subsequent studies to draw pedigrees of families. But the studies made by the author up to this time go to show that nearly all families have the same general type of distribution, that evolution of forms is on the average indifferent, and that most of the so-called adaptations are of no special advantage to their possessors.

Another argument relates to the possible size of mutations. It is often assumed that mutations must of necessity be small, considering that it seems probable that only one unit-factor will be changed at a time. This conception seems to the author to be an unnecessary handicap to the theory of mutation and he proposes that it should be replaced by the hypothesis that no specific change is too great to appear in one mutation. The difference between endemic species of Ceylon and their nearest allies is often very large, as may be deduced from the fact that they are accepted as well-marked Linnean species by such authorities as Trimen and Hooker. But in many cases they are even larger. For instance, *Coleus elongatus,* which occurs only on the top of Ritigala and here only in about a dozen of individuals, differs so much from all other *Colei,* that it may well be regarded as subgenerically distinct. And for the 17 endemic genera, which have only one species each, it seems at least very probable that the whole genus has arisen at a single step.

In concluding I might state that my own studies on the production of new forms among the Œnotheras have of late led me to the conclusion that mutations are in many cases of a far more complicated nature than has been assumed until now. Many of them, as for instance the production of *O. rubrinervis, O. nanella* and *O. gigas,* involve the simultaneous change of two or more characters, in some cases of quite a large number of unit-factors. Why these changes should so regularly go together, we do not, as yet, know, but the fact goes to increase the analogy between the experimental mutations of these plants and the mutations in the wild condition of the Ceylon endemics.

From the facts adduced by Willis, and reviewed in this article, it seems obvious that the parallelism of natural and experimental mutations is a very close one.

HUGO DE VRIES

ELECTRICAL DISCHARGE BETWEEN CONCENTRIC CYLINDRICAL ELECTRODES

IN operating vacuum tubes we invariably use an induction coil or an electrostatic machine. The discharge in either case is never quite steady and hence these methods of operation do not lend themselves well to a critical study of the growth of the cathode dark spaces. A steady, and of course continuous, discharge may be had if the current is drawn from a high potential storage battery. Ordinarily it takes more cells than are available; however, by a right choice of conditions a rather extended study may be made with direct current potentials of less than 1,000 volts. The following experiments with concentric cylindrical electrodes were performed recently by the writer in class demonstration.

The discharge vessel consists of an ordinary

three-quart battery jar. A hole bored through the bottom receives the evacuating tube, the junction being made airtight with ordinary sealing wax. The lip of the jar is ground flat to receive the plate glass lid. The junction here is made by means of the frequently used half-and-half wax, beeswax and resin. This wax because of its low melting point admits of easy removal of the glass plate. The electrodes are concentric cylinders and may well be made of sheet aluminum—one electrode to fit snugly the inner wall of the jar, and the other mounted on a cylinder of glass tubing about 1½ inches in diameter, which in turn is supported accurately concentric by sealing wax from the bottom of the jar. Outside connections to the electrodes are made by fine bare copper wire run out through the waxed joints. The assembled discharge vessel is shown at *a* in Fig. 1.

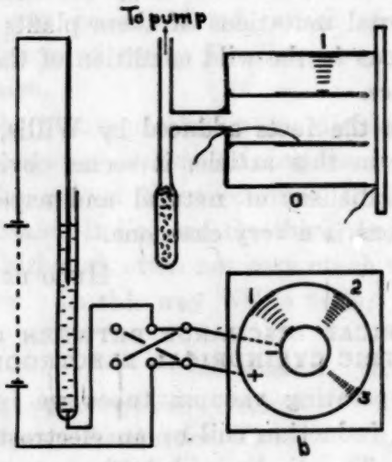

Fig. 1.

The vessel may be exhausted by a Gaede mercury or a Gaede piston pump and, if desired, the vacuum carried farther by the use of charcoal and liquid air, though the latter is not necessary. The potential employed by the writer to produce the discharge was furnished by a cabinet of high potential storage cells of 1,000 volts.

Two methods of operating were employed. In the first an adjustable water resistance is connected in series with the cells and discharge vessel as shown at *b* in Fig. 1. When the vacuum is right a beautiful discharge will make its appearance as patches of light on the electrodes. These patches of light, when there is considerable resistance in the circuit and the vacuum is not very high, will be opposite each other and the discharge, as a whole, will wander about, sometimes swinging entirely around, or at times travelling to the edges of the electrodes, only to break away and move to some other point. The movement of the cathode glow (which is the smaller and hence the brighter) is similar to that of the cathode star over the surface of mercury in a mercury vapor lamp. These areas grow as the vacuum improves when ultimately the entire surface of each electrode is covered. Or, with the vacuum kept constant, the areas may be made to increase in size by cutting out resistance. Hence by improving the vacuum and at the same time cutting out resistance the discharge, if the inner cylinder is made cathode, grows rapidly into a brilliant bull's-eye. The appearance is very realistic, for if now resistance is cut in, the dark space around the cathode (as is evident after a moment's reflection) grows smaller, and *vice versa*. Its

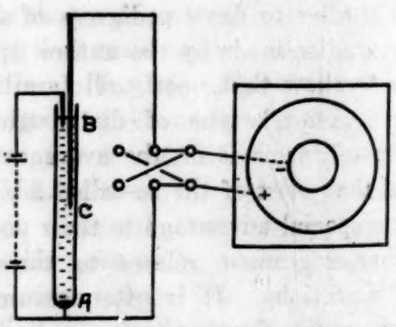

Fig. 2.

outline is exceedingly sharp and perfectly steady, and yet, though the discharge appears very brilliant, the current required may not exceed 20 milliamperes.

This form of discharge vessel offers an interesting method for the study of the striations and their relative spacing with reference to the impressed discharge potentials. These effects are best shown when the vacuum is not too high and the discharge potential is adjusted to give a patch on the cathode, which

we will take as the inner cylinder, of about one square centimeter in area. Under these conditions the Faraday dark space should be about 8 mm. in length, and the Crookes dark space should be just visible between the velvety cathode glow and the cathode electrode. Another prerequisite is that the discharge must not cling to the edge of the aluminum electrodes, but should occupy some intermediate position as shown at 1 in *a*, Fig. 1. In this position the characteristics of the discharge are shown with exceeding clearness. If now some additional resistance is cut in, the area of the discharge will become less, the Faraday dark space will shorten, the positive column will move towards the cathode, and the number of striæ in it will increase, the extra striæ being, as it were, drawn out of the anode. The configuration is perfectly steady except that the discharge, as a whole, is liable to wander. This transition may be continued by a still further increase of the resistance in the circuit, the dark space becoming ever shorter, the positive column lengthening and at the same time shrinking in area and the striæ increasing in number, all without loss of outline or brightness. Finally, the discharge will cease. The various stages are suggested at 1, 2, 3 in *b*, Fig. 1.

In the second method the discharge vessel with its commutator is placed in a derived circuit (Fig. 2). This arrangement enables the discharge potential to be continuously varied over a wide range, and hence for a given vacuum the relation between the length of the dark space and the impressed voltage may be exhibited. Again this arrangement enables the minimum potential to be readily determined that will maintain a discharge. As an example, for a given vacuum with the resistance AC equal to 1/3 that of AB the discharge was observed to just pass, indicating that the potential necessary was 330 volts.

Additional phases of the experiment will suggest themselves to the operator.

CHAS. T. KNIPP

LABORATORY OF PHYSICS,
UNIVERSITY OF ILLINOIS,
March 4, 1916

UTAH ACADEMY OF SCIENCES

THE ninth annual convention of the Utah Academy of Sciences was held in the chemistry lecture room of the University of Utah. Three sessions were held: one at eight P.M., Friday, April 7, one at ten A.M., Saturday, April 8, and the closing session at two P.M. of the same day. Dr. Harvey Fletcher presided at all of the sessions.

Dr. E. G. Peterson, U. A. C., and Professor Carl F. Eyring, B. Y. U., were elected to fellowships in the academy. The following were elected members: Professor George B. Caine, U. A. C., Dean Milton Bennion, U. U., Professor Newton Miller, U. U., Professor A. L. Matthews, U. U., Dr. George S. Snoddy, U. U., Miss Hazel L. Morse, East High School, Salt Lake City, C. Arthur Smith, East High School, Salt Lake City, C. Oren Wilson, East High School, Salt Lake City, Professor Estes P. Taylor, U. A. C., Dr. A. P. Henderson, B. Y. U., and Edgar M. Ledyard, Salt Lake City.

Captain Francis Marion Bishop, a companion of Major Powell in his famous explorations of the Uinta Mountains, was elected to honorary life membership.

The following officers were elected for the ensuing year:

President—Dr. Frank Harris, U. A. C., Logan.

First Vice-president—Dr. L. L. Daines, U. U., Salt Lake City.

Second Vice-president—Professor Carl F. Eyring, B. Y. U., Provo.

Councillors—Dean J. L. Gibson, U. U., Dr. W. E. Carroll, U. A. C., W. D. Neal, Salt Lake City.

The following lectures and papers were presented:

"Industrial Research in U. S. A.," by Dr. Harvey Fletcher, B. Y. U.

"The Alkali Content of Certain Utah Soils," by Dr. Frank S. Harris, U. A. C.

"The Agricultural College and Scientific Research," by Dr. E. G. Peterson, U. A. C.

"Selecting Holstein-Friesian Bulls by Performance," by Dr. W. E. Carroll, U. A. C.

"Peyote, an Indian Narcotic," by A. O. Garrett, East High School, Salt Lake City.

"An Epidemic of Colds with *Micrococcus catarrhalis* as Causative Agents," by Dr. L. L. Daines, U. U.

"The First Recorded Case of Rabies in Utah," by Dr. L. L. Daines, U. U.

"Botulinus Poisoning from a Vegetable Source," by Dr. L. L. Daines, U. U.

"Comparison of Methods of Treatment for

Grain Smuts,'' by M. Rich Porter, Salt Lake City.

''The Value of Gaseous Ionization in Hydrogen,'' by Professor Carl F. Eyring, B. Y. U.

''A New Count Method of Measuring the Elementary Electric Charge,'' by Dr. Harvey Fletcher, B. Y. U.

''Our National Awakening to the Importance of Science,'' by Dr. W. C. Ebaugh, Salt Lake City.

A. O. Garrett,
Permanent Secretary

ANTHROPOLOGY AT THE WASHINGTON MEETING[1]

The annual meeting of the American Anthropological Association was held December 27–31, 1915, at the United States National Museum, Washington, D. C., its scientific sessions being in affiliation with Section I of the Second Pan-American Scientific Congress, the Nineteenth International Congress of Americanists, the American Folk-Lore Society, the American Historical Association, and the Archeological Institute of America. By virtue of this affiliation the attendance was large and the list of papers presented bearing on anthropology was unusually long.

In honor of the occasion, the United States National Museum made provision for special exhibits. These included: (1) Physical Anthropology, by Dr. A. Hrdlicka; (2) Indian Treaties of Historical Importance; (3) Economic Plants and Plant Products, by W. E. Safford; (4) Archeological Exhibits, by W. K. Moorehead, A. V. Kidder, and Julio Tello, and (5) Photographs, by Frederick Monsen and the Rodman Wanamaker Expedition.

Interwoven with the scientific sessions there was an elaborate social program, comprising a reception by the Secretary of State and the United States delegation, and one by the governing board of the Pan-American Union, both held in the Pan-American building; a reception by the regents and secretary of the Smithsonian Institution; a luncheon by the National Geographic Society; a reception by the trustees of the Carnegie Institution of Washington; a dinner and reception by the Cosmos Club; and finally after the close of the meetings, the reception at the White House by the President and Mrs. Woodrow Wilson.

A number of important resolutions were adopted; some of these were in the nature of joint resolutions, others concerned only the American Anthropological Association, as will be seen from the contexts:

[1] Report prepared by George Grant MacCurdy at the request of the General Secretary, A. Hrdlicka.

RESOLUTION RELATING TO THE DESIRABILITY OF UNIFORM LAWS CONCERNING ARCHEOLOGICAL EXPLORATION

Section I

Whereas, many parts of the American continent are rich in archeological remains, such as ruins, monuments and burial sites, containing many examples of industry and art of the aborigines.

And whereas, scientific explorations of these remains with the study of resulting finds are objects of utmost importance, for on their basis only will it be once possible to reconstruct the lost history of the American race.

And whereas, in order that such remains may be saved to science and not be wantonly exploited or destroyed before they could be studied, it is essential that proper laws and regulations be adopted by the various countries where such remains exist, the object of such laws and regulations being to hinder or prevent as far as possible the digging or other destruction of such remains by unqualified persons; to prevent trade in pottery and other articles recovered from the ruins and graves, and at the same time not only to enable properly qualified scientific men both indigenous and of other countries to undertake and carry on scientific explorations and collections.

And whereas, the majority of the American republics have now some laws relating to antiquities, although these laws are unlike in the different countries and in some instances are such that they have resulted more in restraining than in advancing properly qualified research.

Therefore it is hereby Resolved by the Second Pan-American Congress, that it is highly desirable that the various American republics arrange by the appointment of suitable delegates, possibly from among their official representatives at Washington, for joint action on this important subject, with the view of formulating generally acceptable and substantially uniform laws relating to the conservation, exploration and study of archeological remains in their several jurisdictions; laws which on one side will effectively safeguard these remains from wanton destruction or exploitation, and on the other will aid and stimulate properly organized and accredited research in these directions.

RESOLUTION RELATING TO THE ADVANCE OF ANTHROPOLOGICAL RESEARCH IN THE VARIOUS AMERICAN REPUBLICS

Whereas, in various parts of the American continent there are remnants of the aboriginal popu-

lation, a study of which is of great importance to science.

AND WHEREAS, many of these remnants are very imperfectly known and are rapidly disappearing.

AND WHEREAS, properly made and preserved collections, ethnological and physical, are among the most precious scientific and educational assets of a nation.

Therefore be it Resolved by the Second Pan-American Congress, that delegates to the congress be urged to use every opportunity to impress upon their respective governments, institutions and people the importance of promoting research in this field, of organizing surveys for the study of the primitive tribes, and of building up national and local museums for the preservation of the data and materials collected.

The two foregoing resolutions were passed not only by the American Anthropological Association, but also by the International Congress of Americanists, the latter providing for an intermediary local bureau in Washington consisting of W. H. Holmes, F. W. Hodge and A. Hrdlicka.

RESOLUTION ON THE DEATH OF PROFESSOR FREDERIC WARD PUTNAM

(Prepared by Alfred M. Tozzer and Marshall H. Saville.)

WHEREAS, by the death of Professor Frederic Ward Putnam, the American Anthropological Association has lost one of its most eminent founders, one of its most eminent supporters, and one of its most lovable characters;

Be it Resolved, that the Association here express the sense of this great loss to American anthropology, a loss that is felt not only by the many pupils of Professor Putnam in the several institutions throughout the country, but also by those who have long been connected with Professor Putnam through all the years of struggle to make anthropology a recognized field of scientific endeavor; and

Be it further Resolved, that these minutes be spread upon the records of the association and also be sent to the members of Professor Putnam's family.

RESOLUTION OF THE AMERICAN ANTHROPOLOGICAL ASSOCIATION RELATING TO THE DESIRABILITY OF RESUMING THE OPERATIONS OF THE ETHNOLOGICAL SURVEY OF THE PHILIPPINE ISLANDS

(Prepared by Edward Sapir and R. H. Lowie.)

The members of the American Anthropological Association have learned with great regret of the decision to suspend the operations of the Ethnological Survey of the Philippine Islands. The native populations of the Philippine Islands are among the most interesting of the globe from a scientific point of view. They include a pygmy race whose study will shed light on the physical anthropology and culture of one of the most primitive divisions of mankind. On a higher level a host of Malay tribes require investigation for the purpose of determining their relations with one another and with alien groups. In short, the Philippines offer an unusually rich field for important research which should not be left to the accident of private interest.

It is therefore respectfully urged by the American Anthropological Association that the proper authorities authorize the resumption of anthropological research in the Philippine Islands at the earliest opportunity.

On January 19, 1916, the secretary received a reply from Mr. J. L. Hunt, assistant to the chief of the Bureau of Insular Affairs (War Department), from which the following is taken:

"Anthropological work which has been carried on in the Philippine Islands has not been done by the federal government or maintained at federal expense, but has been carried on by the Philippine government through its Bureau of Science. Some months ago the Philippine government found it necessary greatly to curtail its expenses on account of a considerable falling off in its revenues, and among other activities of the Philippine government which had to be suspended or discontinued were those in connection with anthropology.

"A copy of your letter is being transmitted with its inclosure to the governor-general of the Philippine Islands at Manila for consideration by the proper authorities there."

RESOLUTION FAVORING BILL TO DISCONTINUE THE USE OF THE FAHRENHEIT THERMOMETER SCALE IN GOVERNMENT PUBLICATIONS

WHEREAS, there is now pending in congress a bill, known as H. R. No. 528, to discontinue the use of the Fahrenheit thermometer scale in government publications:

Be it Resolved, that said bill have the support of the American Anthropological Association.

A vote of thanks to the regents and secretary of the Smithsonian Institution for the facilities so generously placed at the disposal of the association and for the reception at the National Museum was unanimously carried.

On invitation from Dr. P. E. Goddard, it was voted to hold the next regular meeting of the Association at the American Museum of Natural History, New York City, on December 27–30, 1916, in affiliation with Section H of the American Association for the Advancement of Science.

Nearly one hundred titles were offered in the joint program; with but few exceptions the author was present and read his paper. A large majority of the abstracts were presented through the International Congress of Americanists.

The Place of Archeology in Human History: W. H. Holmes.

The term history as applied to the human race is a comprehensive designation corresponding with the term anthropology, which is defined as the science of man. The sources of information to be drawn upon in these researches are comprised under two principal heads: (1) intentional or purposeful records, and (2) non-intentional or fortuitous records. The intentional records are of five forms, as follows: (1) Pictorial, as in pictures and pictographs; (2) major objective, as in commemorative, monumental works; (3) minor objective, as in *quipu* and *wampum;* (4) oral, as in tradition and lore; (5) written, as in glyphic and alphabetic characters. With each of these categories goes necessarily a mnemonic element—a very considerable dependence upon memory. Fortuitous records take numerous forms: (1) The great body of products of human handicraft to which no mnemonic significance has ever been attached; (2) the non-material results of human activity as embodied in language, beliefs, customs, music, philosophy, etc.; (3) the ever-existing unpremeditated body of memories which accrue to each generation and are in part transmitted adventitiously; (4) the record embodied in the physical constitution of man which, when properly read, aids in telling the history of his development from lower forms; (5) the records of intellectual growth and powers to be sought in the constitution of the mind; (6) the environments which may be made to assist in revealing the story of the nurture and upbuilding of race and culture throughout the past.

It is from these diversified records, present and past, that the story of the race must be derived. Archeology stands quite apart from this classification of the science of man, since it traverses in its own way the entire field of research; howbeit, it claims for its own more especially that which is old or ancient in this vast body of data. It is even called on to pick up the lost lines of the earlier written records, as in the shadowy beginnings of glyphic and phonetic writing, and restore them to history. It must recover the secrets of the commemorative monuments—the tombs, temples and sculptures intended to immortalize the now long-forgotten great. It must follow back the obscure trails of tradition and substantiate or discredit the lore of the fathers. It must interpret in its way, so far as interpretation is possible, the pictorial records inscribed by the ancients on rock faces and cavern walls, these being among the most lasting and purposeful records. All that archeology retrieves from this wide field is restored to human knowledge and added to the volume of written history. Archeology is thus the great retriever of history.

The Origin and Destruction of a National Indian Portrait Gallery: F. W. Hodge.

Description of the efforts made in the early years of the last century to establish at Washington a national gallery of Indian portraits, particularly the part taken therein by Thomas L. McKenney, superintendent of Indian trade and later in charge of the Office of Indian Affairs. The growth of the collection; the artists engaged in the task; the use of the portraits in illustrating McKenney and Hall's elaborate and expensive work on the Indians; the transfer of the collection to the National Institute and later to the Smithsonian Institution; the addition of the loan collection of Indian paintings by J. M. Stanley, and the final destruction of almost the entire collection by fire in 1865.

Indications of Visits of White Men to America before Columbus: William H. Babcock.

Ancient writers and voyagers knew the Atlantic as far west as Corvo and the Saragossa Sea, approximately half-way to America, and some of them describe or mention a continent on the western side of that ocean; but these statements lack distinctive touches which might serve as tests of reality.

Medieval maps and Norse sagas give reason to surmise that early Irish mariners reached the northeastern outjutting elbow of America surrounding the Gulf of St. Lawrence, which they called Brazil. This would probably be considerably before the Norse arrival in Iceland near the close of the ninth century, for the Norsemen found that Irish monks had preceded them there.

About 985 Eric the Ruddy of Iceland planted a colony in Greenland, which survived for 450 or

500 years. In the year 1000, according to the more credible form of the saga, his son Lief discovered Vinland or Wineland, otherwise the mainland of America. His sister-in-law, Gudrid, and her husband, Thorfinn Karlsefni, explored a part of the American coastline, about the years 1003 to 1006, but failed in the attempt to establish a permanent settlement. Mainland America was probably repeatedly visited from Greenland and Iceland. One such visit is recorded positively as occurring in 1347.

Before 1367 a Breton expedition met with partial disaster at an island farther south and west than the Brazil before referred to. It would naturally be some point on or off the lower American Atlantic coast line, possibly Cape Cod or the Bermudas. Many maps show this more remote island, usually of crescent form, and most often having the name Man (Mam) or Mayda.

Probably Behaim's globe of 1492 is substantially right in stating that a Spanish (Portuguese?) vessel sailed to Antillia in 1414. Beccaria's map of 1435 presents as "Newly reported islands" an insular group of four—Antillia, Salvagio, Reylla and I in Mar. These are repeated more or less completely on the maps of Bianco, 1436; Pareto, 1455; Roselli, 1648, the Weimar map sometimes credited to 1424, but probably Freducci's about 1481, Benincasa, 1482, and the Laon globe of 1493. They must be what Justin Martyr (1511) calls "The Islands of Antillia." Apparently the latter island was Cuba.

The 1448 map of Bianco shows a long coast line on the edge of the parchment opposite Cape Verde, with an inscription in a Venetian dialect, variously read as stating 1,500 miles for the interval or the length of shore. It would seem that some one may have anticipated the experience of Cabral in reaching South America by this route. The discussion of this point before the Geographical Society brought out an elaborate review of the Portuguese records of westward discovery by J. Batalho Reis, which presents many valuable items of western discovery. But there seems nothing in them clearly to indicate voyages to America before Columbus. Divers other claims have been made for Normans, Poles, Basques and Orkneymen, but are hardly to be trusted.

Vineland—Its Probable Location: A. GAGNON.

In what part of North America was Vineland located? The author attempts to throw some light on the question through the help of the sagas, which date from the twelfth to the fourteenth century, and which recount the earliest voyages to Greenland and Vineland.

Pan-American Topic: ADRIAN RECINOS.

The author considers of prime necessity the conservation of architectural monuments and of all objects belonging to the domain of archeology and anthropology, in order to be able to arrive at a clear notion of the pre-Columbian history of the Western Hemisphere. He believes it entirely feasible that the different American countries should pass uniform laws for the protection of antiquities, since the laws on this subject show great similarity in the different countries to-day. What he thinks has been lacking up to the present time in the different countries is a special legislation aimed to encourage systematic investigations in the field of archeology and anthropology. He believes it advisable that the American governments should agree that the existing museums and libraries in the respective countries should harmonize their work and exchange duplicate objects which they may possess.

Anthropology in the Museum of the Buffalo Society of Natural Sciences: HENRY R. HOWLAND.

From its organization in 1861 the Buffalo Society has been active in the collection and study of anthropological and ethnological material, in which direction its collections and publications are especially noteworthy. In late years its activities have been greatly increased and its archeological collections materially augmented by systematic field work and careful study of results. Mr. Howland's paper calls attention to the richness of materials for such investigation and study in western New York, where, in pre-historic and early historic days, the aboriginal inhabitants were notably the Indians of the Neutral Nation, the Wenrohronons, and southward and westward of the Niagara frontier, the people called by the Jesuits the "Nation of the Cat." All of these ancient sites, burial places, etc., have been critically examined and studied by the Buffalo Society, and the results, with maps, etc., published in a bulletin of 150 pages in 1909.

A later bulletin described by Mr. Howland covers rich results of field work carried on further eastward where those large Seneca towns were destroyed by the French Governor Denonville in 1687. Another bulletin is now ready for the press in which are traced the early migrations of the Seneca before their discovery by white men.

Mr. Howland briefly calls attention to the large educational work which has been carried on by the

society for many years, correlating its work directly with the public school system of Buffalo to an extent not attempted elsewhere, and predicts for the future extended work in anthropology as well as in other branches of natural science.

Excavation of a Pre-Lenape Site in New Jersey: E. W. Hawkes.

Few regions in North America are of greater interest archeologically than the north Atlantic seaboard as throwing light on the possible antiquity of man in America. Particularly in the Trenton area we find evidence of two culture levels—that of the modern Delaware Indians and an argillite culture which has been the subject of much dispute. During last summer the author and his colleague, Mr. Ralph Linton, made an excavation of an Indian site near Moorestown, New Jersey, which promises to throw some light on the comparative age of the two cultures.

Modern Indian implements were found in the upper stratum of leaf mold, six inches deep; argillite implements of an intermediate type in the center of the next stratum, a layer of yellow sand, five to seven feet deep; and, at the juncture of the yellow sand with a stratum of white glacial sand, extensive remains of a ceremonial site were uncovered, which consists of caches of argillite points and bannerstones grouped in three more or less parallel rows around a great central fire-pit. The fire-pit had blackened the layer of white sand for two feet down, but showed no trace above, thus proving conclusively that the material of the two layers was clearly separate.

The probable age of the levels rests in the geologic formation of the site, which was in the shape of a mound. If laid down in water, which is geologically probable, the points from the lowest level would belong to glacial times; if wind-blown, which is more probable, the argillite implements would be comparatively recent. The presence of bannerstones among them would appear to be an argument against any great antiquity. The number of types of argillite implements found extends the limits of this culture, but raises the broader question of whether it was continued into a more modern era than has been supposed to date.

Excavations on the Abbott Farm at Trenton, New Jersey: Clark Wissler, C. A. Reeds, and Leslie Spier.

This report is on one phase of a systematic investigation of the chronological relations of Coastal Algonkin culture. Mr. Alanson Skinner will report separately on another aspect of the problem. In the course of their local field-work the writers encountered traces of what seemed to be the argillite culture described by Volk and Abbott as found in the yellow drift at Trenton. Artifacts were found in the yellow drift at a few other points near the terminal moraine, sites that will be excavated in the near future. For the sake of comparative data, and since the Trenton site is about to be destroyed by railway extension, considerable attention was given to it. The problem for the next few years will be the study of the yellow drift deposits farther north. This report will deal almost entirely with the site on Dr. Abbott's farm at Trenton.

A. Archeological Report, by Leslie Spier.—Data are offered in support of the following: The excavations so far made in the yellow drift of the Trenton district have yielded artifacts in quantity sufficient to warrant the conclusion that typical conditions are here represented. The artifacts are culturally distinct from those of the Delaware Indians found in the surface soil. They are distributed throughout the site, lying in a characteristic manner in the upper portion of the yellow drift, and entirely separate from the artifacts in the surface soil. They have not penetrated the yellow drift from the surface soil above, but bear an intimate relation to the geological structure of the drift.

B. The Application of Statistical Methods to the Preceding Data, by Clark Wissler.—It is shown that the tabulations of artifacts and pebbles from the several trenches give typical frequency curves. Also that they are in each case component parts of a single series. There is here the suggestion of a new departure in archeological method, or rather the introduction of the methods of precision used in many other sciences.

C. Geological Report, by Chester A. Reeds.—The geologic history of the Trenton district is long and varied. The triassic overlap on the rocks of Cambrian and pre-Cambrian age extends from Trenton northwestward. The marine beds of the Cretaceous, Tertiary, and early Pleistocene periods overlap on the Triassic rocks along a line from Trenton to New York. During late Glacial and post-Glacial times the drainage was in part normal to and in part parallel to this line. The streams of to-day occupy the same relative positions as they did in late Pleistocene times, but their valleys have been modified somewhat by subsequent corrasion and aggradation. In the comparatively recent geological past deposits containing artifacts

were made on the delta of Assanpink creek. At the present time these deposits occupy a position about sixty feet above the flood plain of Delaware river. Most of the artifacts which have been collected come from the Lalor and Abbott farms just to the south of Trenton. In the Trenton Folio of the U. S. Geological Survey the bed containing the artifacts, referred to locally as the "yellow drift," has been mapped with the Cape May formation. The geologic development of the Trenton district is treated briefly and is followed by a discussion of the topography, drainage, valley sculpturing, and geologic age of the terrace deposits. The petrologic character of the material from the trenches is also considered, as well as the red band deposits which have been found in the artifact-bearing sands.

Archeological Work in Northern Nova Scotia: HARLAN I. SMITH.

The archeological work in northern Nova Scotia, carried on for the Geological Survey of Canada, was chiefly in the shell-heaps of Merigomish harbor, and resulted in obtaining perhaps the most complete and detailed data thus far secured regarding the archeology of Nova Scotia, as well as one of the three largest collections of Nova-Scotian specimens. No burials were discovered. These shell-heaps are situated usually in the most sheltered places, generally on southern shores; and on islands rather than the mainland, although there are some small heaps on the latter. The sites are above high tide, but usually on low places sheltered from the wind by bluffs. They are probably the remains of Micmac villages. Chipped points of stone for arrows, celts of stone, pottery, and sharpened bones were very numerous. Little knives or chisels, made from beaver teeth, harpoon points of bone, and other artifacts were frequently found. Gouges were entirely absent, although common enough from Nova Scotia, and represented in some collections by about as many specimens as there are of celts. On the whole the quantity of specimens found in the shell-heaps was much less than would be found in some village sites in southern Ontario.

Remarkable Stone Sculptures From Yale, British Columbia: HARLAN I. SMITH.

Several remarkable stone sculptures, found near Yale, British Columbia, are kept in private collections, but have been photographed for the Geological Survey of Canada. They are among the most striking archeological sculptures known from Canada.

The Culture of a Prehistoric Iroquoian Site in Eastern Ontario: W. J. WINTEMBERG.

The inhabitants of the Roebuck site, a prehistoric Iroquoian palisaded village site in Grenville county, Ontario, explored for the Geological Survey of Canada in 1912 and 1915, appear to have been a peaceful agricultural people. Most of the artifacts are those usually found on Iroquoian sites in Ontario and New York state. Chipped stone points for arrows and spears are scarce, although those made of bone and antler are common. Unilaterally and bilaterally barbed bone and antler points for harpoons, and barbed fish-hooks made of bone, were found. Some of the pottery vessels had handles. Awls are the most numerous objects made of bone. A perforated wooden disk was found in the muck surrounding a spring. Pieces of carbonized rope or cord and a carbonized coarse fabric are the only textiles recovered. Beads are of bone, shell, stone, and pottery. Pieces of human skull were fashioned into perforated round gorgets. A few pieces of stone gorgets were also found. Rubbed and also hollowed phalanx bones of the deer, and disks rubbed and chipped from stone and potsherds, were used probably in playing games. Some large awls or daggers were made of human ulnæ. Fragments of pottery pipes, some having modeled human faces and animal heads on the bowls, are numerous. Stone pipes are scarce. Some pipes are made from deer scapulæ. A phallus carved from antler was also found. Eighty-three skeletons were exhumed. Judging from the condition of stray human bones, ceremonial cannibalism may have been practised.

Prehistoric Sites in Maine: WARREN K. MOOREHEAD.

The department of archeology of Phillips Academy spent five seasons in the exploration of ancient and modern Indian sites in Maine and New Brunswick. The maps covering the regions visited record more than three hundred places where former aboriginal occupancy is in evidence. The purpose of the work in Maine was to indicate the evidence of aboriginal occupancy and to determine whether the sites represent more than one culture. Sites occupied by various divisions of the Algonquian stock appear to be common, and range from those indicating contact with Europeans to others which appear to be prehistoric.

Occupying an area of approximately one hundred and fifty by one hundred kilometers in the central southern portion of the state are certain cemeteries or deposits of peculiar artifacts, accompanied by large quantities of brilliant red ochre or

hematite. As there is no historical reference to the people responsible for this culture, the term "Red Paint People" is offered. Nineteen of these deposits or cemeteries have been found—three by Harvard University, six by citizens of Maine, and ten by the Phillips Academy survey. The contents of these Red Paint cemeteries or deposits represent limited and fixed types, most of which do not occur on the surface of village sites, and are absent from the shellheaps on the coast of Maine. The ochre or hematite occurs in large quantities in central Maine at the Katahdin Iron Works, where there is an iron outcrop.

In the Red Paint deposits occur no pottery, pipes, crude axes, or hammers. Adz blades, gouges, long, heavy perforated stones, "plummets," slender slate spears, and kindred types predominate. The persistence of these seven or eight types is remarkable, and differentiates these graves from all others in Maine. Twenty per cent. of the stone implements show disintegration, which may be due to chemical action of the ochre in contact with the tools.

While it has been thought that this culture extends toward the east, the exploration conducted in the summer of 1915 indicates that there is a gradual change in the types on Georges river, which is the westernmost point the survey has reached. The author, therefore, gives it as his opinion that the types will be found to merge with the Algonquian in western Maine.

Brief comparative reference is made to the shellheaps along the Maine coast. In conclusion, the author refers to the Beothuk traditions and descriptions cited by early voyagers in Newfoundland. Whether the sites of the Red Paint people will be found east of the mouth of St. John River in New Brunswick will be determined after that region has been explored. The author shares with the late Professor F. W. Putnam and Mr. C. C. Willoughby the belief that the Red Paint culture is one of the oldest in the United States.

Explorations of the Mounds and Caverns of Tennessee: W. E. Myer.

An extensive Indian town at Castalian Springs, Tennessee, was explored. This settlement covered about fifty acres and consisted of five mounds, a line of embankment, and a large stone-grave cemetery. One of the smaller mounds contained more than one hundred stone-grave burials and yields many examples of aboriginal workmanship. Many of the ornaments, while of local make, seem to show the influence of Mexican culture. The graves yielded many traces of curious and unique customs, such as the burial of two or more bodies in one coffin; the raking to one side of the bones of a former burial and placing a new body in the coffin; the burial of fleshless bones in bundles; the burial of crania unaccompanied by other bones, in small stone boxes; the burial of children with adults in such positions as to arouse suspicion that the child may have been placed in the grave alive. One author explored many of the caverns and rock-shelters of the Cumberland valley, which will be described and illustrated.

The Wesleyan University Collection of Antiquities from Tennessee: George Grant MacCurdy.

The collection in question was gathered by the late George D. Barnes in the vicinity of Chattanooga, prior to and during 1895. It is said to have come almost wholly from Williams island, in the Tennessee river, and largely from a single mound. The collection, which numbers several thousand specimens, was bought for Wesleyan University, Middletown, Connecticut, by Mr. A. R. Crittenden of that city; and with the exception of the small portion sold to the Natural History Society of Marion, Massachusetts, is now in the Judd Museum.

Among the notable specimens are the shell gorgets. A large majority of these belong to the class in which representations of the rattlesnake play an important rôle. There are several so-called scalloped disks, one gorget depicting the human form, and a few mask-like shell ornaments.

Of special interest are the button-shaped ornaments of shell with two holes for fastening or suspension in the center of a squarish field. Similar objects were found by Mr. Clarence B. Moore in a burial urn from the grave of an infant at Durand Bend, Dallas county, Alabama. They were near the neck of the child as if they might have formed a necklace or been attached to a garment.

Wesleyan University is to be congratulated on having secured so many important antiquities from a given locality in Tennessee. It is, however, unfortunate that a prehistory of Williams Island could not have been written during the lifetime of Barnes (and of Loper, late curator of the Judd Museum). The case of this collection thus illustrates anew not only the desirability of expert scientific control in archeological excavations, but also the duty imposed on the collector to see that the results are published promptly.

Some Mounds of Eastern Tennessee: George Grant MacCurdy.

About forty-five years ago the Rev. E. O. Dunning, of New Haven, spent two or three seasons in excavating certain ancient mounds of eastern Tennessee. Part of this work was under the auspices of Peabody Museum of Yale University, and part under those of Peabody Museum of American Archeology and Ethnology at Harvard University.

Brief mention of Mr. Dunning's explorations and the collections he obtained is made in the Fifth Annual Report of the Sheffield Scientific School of Yale College; and in the Third, Fourth, and Fifth Annual Reports of Peabody Museum at Harvard. Dunning does not seem to have left any notebooks or drawings and plans as a result of his field-work. The original documents bearing thereon are thus confined to the specimens and to his letters preserved in the Yale and Harvard museums. Dunning's explorations covered parts of Knox, Jefferson, Hamblen, Greene, Marion, and Cocke counties, but were limited chiefly to the Brakebill, McBee, Lisle, Lick Creek, and Turner's mounds. Only the first three of these are represented in the collections at Yale; and to them the present paper is confined.

A comparative study of the gorgets found by Dunning in the aforementioned mounds, and those in the Wesleyan University collection, leads the author to the conclusion that the so-called scalloped disks and the gorgets representing the cross are but conventionalized varieties of the realistic rattlesnake gorget. The kinship would be even more apparent were it not for the incompleteness of the record, and the gradual exaggeration and stereotyping of small differences due to conventionalism.

The Archeology of the Ozark Region of the United States: CHARLES PEABODY.

Throughout the region of the "Ozark Uplift" in the states of Missouri and Arkansas are many caves of which a great number have been occupied by prehistoric man.

In the soft deposits (occasionally brecciated) within, are found projectile points and knives, scrapers, perforators, nuclei, and other specimens in stone, pins and awls of bone, rare fragments of pottery, and in a few instances human bones; animal bones are abundant.

The culture as a whole is distinguished from that of the supposedly contemporaneous occupations in surrounding regions by the lack of problematical forms, of elaborate pottery and of careful burials.

The reason for this is not yet clear; the time of occupation of the caves must have been long; whether the occupants were the same tribes as those surrounding, or different, has not yet been determined; neither the theory of "summer resorts" for the lowland Indians nor that of a quite independent occupation seems adequate.

Early Pueblo Indian Missions in New Mexico: L. BRANFORD PRINCE.

The fame of the Franciscan mission churches in California has obscured the history and description of those in New Mexico, and yet the latter are in many respects the more interesting and important. They are very much older and there is far more variety in their history. The earliest California mission was built in 1769, and the story of one is practically the story of all. In New Mexico each mission has its individuality; the first mission was built in 1598, immediately after the colonization, and at least twenty-five were established before 1630. The massive mission structures, whose remains are seen at Abo, Cuara and Tabira, and constitute the most striking historic ruins in the United States, were built, had fulfilled their religious mission, and were finally deserted, before 1679. The peculiar feature of the heavy walls, composed of small, thin stones, is essentially aboriginal and similar to that of a number of the great prehistoric ruins in the Pueblo Bonito and San Juan regions. One remarkable circumstance connected with these massive walls is that they were constructed entirely by the Indian women, in accordance with the then uniform Pueblo custom, as distinctly stated by Benavides in his memorial to the King in 1630.

Archeology of the Tano District, New Mexico: N. C. NELSON.

The American Museum's Southwest Archeological Expedition, which entered the field in 1912, has just finished its contemplated work in the Taño Pueblo district of New Mexico. The region under investigation lies between the Rio Grande and Pecos River, with Santa Fé on its northern border, and covers an area of about 1,600 square miles. Within these limits were located 46 pueblo ruins, some small and some very large, besides numerous small houses and minor sites of archeological interest. Twenty-six of the most important sites were tried out by excavation, about 2,000 rooms being cleared, in addition to a very considerable amount of trenching in refuse heaps and burial grounds.

The results have been gratifying in several respects. About 3,500 artifacts of stone, bone, shell,

wood or fiber, and clay have been added to the Museum collections; and twice that number of common objects, such as mealing stones and the like, were left on the field. Comprehensively stated, the data obtained are of such a character as to warrant the separation of the various ruins into six successive chronological groups, the last two of which are of historic date.

Prehistoric Cultures of the San Juan Drainage: A. V. Kidder.

Omitting non-sedentary tribes, the remains are divisible into three groups. (1) *The Kiva Culture* is the latest; to it belong majority of cliff-dwellings and pueblos of the region. The kiva is a constant feature of the ruins. The problem of interrelation of the ruins and chronological sequence is complicated and best approached by preliminary classification of the remains at present known. There are several well-defined groups: Mesa Verde, Montezuma Creek, Chaco Cañon, Chinlee, Kayenta; also numerous ruins both in and outside these groups which can not yet be classified. Each group is characterized by peculiarities in pottery, architecture, and kiva construction.

(2) *The Slab-house Culture;* closely allied to the kiva culture and may belong to same. Range is not known; so far definitely recorded from but a single locality in northeastern Arizona, where it underlies kiva culture group. Rooms semi-subterranean, of slabs and adobe; apparently no true kivas, and pottery distinct from that of the later ruins of the region.

(3) *The Basket-maker Culture;* probably the earliest of the three. First reported from southeastern Utah. The basket-makers were cave-dwellers, built no stone houses and made little pottery. The textile arts were very highly developed, and they appear to have had several implements not used by the later inhabitants.

The interrelationship of these three cultures can not be determined without much more field work.

Notes on Certain Prehistoric Habitations of Western Utah: Neil M. Judd.

During May and June, 1915, an archeological reconnaissance of several valleys in western Utah was made under instructions from the Bureau of American Ethnology. Limited excavations at a number of widely-separated localities revealed the structural characteristics of the house remains at each site and gave some indication of the cultural attainments of their ancient inhabitants.

An examination of several mounds near Willard, on the northeastern shore of Great Salt Lake, disclosed the ruins of dwellings which must have resembled very closely the well-known winter hogan of the Navaho Indian. Other shelters of the same type were found at Beaver City, in close proximity to rectangular dwellings of adobe; mounds at Paragonah, in Iron County, covered walled habitations similar to the larger structure near Beaver. At the two last-named localities a majority of the ancient dwellings had been single-roomed houses, more or less closely associated with each other. Near Kanab, in Kane County, photographs and measurements of a small cliff-village, consisting of a kiva and four unconnected rooms, were made.

Excavations at these several localities resulted in small collections of archeological material that, like the structures from which they were obtained, seem to point to a cultural relationship between the builders of the three types of primitive dwellings here mentioned.

Notes on the Orientation of Ancient Pueblos, Reservoirs and Shrines in New Mexico: William Boone Douglass.

Description of the ruin area around the communal building known as Puye, on the Jemez plateau, which was carefully surveyed, and the various buildings mapped to show their orientation and grouping. The orientation of Tshirege and Tyuonyi (communal houses of the Jemez plateau) and of their accompanying antiquities is given and a comparison made with the orientation of a Tewa pueblo of the historic period.

Notes on Shrines of the Tewa and other Pueblo Indians of New Mexico: William Boone Douglass.

(1) A detailed description of the "World Center shrine" on Tsikomo peak of the Jemez Mountains, with a reconstruction of the shrine, in which are used the offerings taken from it. (2) A full description of the shrines of La Sierra del Ballo, and the exhibition of a silver ornament taken from one of them. (3) A brief description of the nine shrines of Tonyo, the sacred mountain of the San Ildefonso Indians, to which they retreated and successfully resisted the Spanish invaders during the Pueblo rebellion of 1680–1692. (4) The Cloud shrine and the War God shrine will be briefly described, with reference to the offerings found in them.

George Grant MacCurdy

(*To be continued*)